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The Role of Specificity and Abstraction in Creative Idea Generation

Thomas B. Ward and Merryl J. Patterson
Texas A&M University

Cynthia M. Sifonis
Oakland University

ABSTRACT: Three experiments examined the relationship between approaches to a creative generation task and the novelty of the resulting products. Participants were given the task of imagining life on other planets and they received instructions intended to encourage them to formulate the task in either very specific ways (e.g., thinking of specific Earth animals) or more abstract ways (e.g., thinking of environmental conditions and general survival needs). The latter instructions led to more novel creations. The results are discussed in terms of the malleability of people's approaches to creative generation, the role of problem formulation and the link between abstraction and novelty.

A common form of creative behavior is the generation of novel instances of familiar conceptual domains. This occurs when science fiction writers envision new alien creatures, when chefs concoct new soup recipes, when engineers design new mechanical devices, and when children invent new variations on familiar games. Ward, Smith, and Vaid (1997) have referred to these kinds of activities as *conceptual expansion*, that is, pushing the boundaries of a given domain by mentally crafting new exemplars and bringing those new ideas to fruition. Although perhaps not as impressive as making dramatic insightful leaps, this more mundane activity is nevertheless creative in the most basic sense that it leads to products that are both novel and appropriate to some goal.

Recent laboratory research has begun to examine the processes involved in conceptual expansion and how the properties of existing knowledge constrain and direct that expansion. Ward (1994), for example, gave undergraduate students the task of imagining animals that might exist on other planets and found that the vast majority of their creations—generally more than 90 percent—included key properties of Earth animals, such as eyes, legs and bilateral symmetry. Thus, the most typical properties of people's existing animal concepts served as guides to the form of the novel creatures. Similar results have been found even when people are asked to make their creatures wildly different from animals on Earth (Ward & Sifonis, 1997). They have also been found for a variety of conceptual domains, including imaginary coins, faces, fruit, and tools (Bredart, Ward, & Marczewski, 1998; Rubin & Kontis, 1983; Ward, Patterson, Sifonis, Dodds, & Saunders, 2002).

It is not surprising that newly created instances of a domain would share key properties with known exemplars, but what is important is an understanding of the processes by which those commonalities are produced, and how differing strategies lead to either more or less novelty in the new products. Identifying the links between people's approaches and the novelty of their creations holds the potential for improving creative functioning, and is the focus of this study.

An organizing framework for this project is the path-of-least-resistance model (Ward, 1994; 1995;

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Correspondence and requests for reprints should be sent to Thomas B. Ward, Center for Creative Media, Box 870172, University of Alabama, Tuscaloosa, AL 35487–0172. E-mail address: ward@ccm.ua.edu.

Ward, Dodds, Saunders, & Sifonis, 2000), which states that, when people develop new ideas for a particular domain, the predominant tendency is to retrieve fairly specific, basic level exemplars from that domain, select one or more of those retrieved instances as a starting point, and project many of the stored properties of the instances onto the novel ideas being developed. This default tendency is not viewed as a rigid constraint, but only as the most common strategy. Other, more abstract strategies are possible.

Consistent with expectations from the path-of-least-resistance model, 60 to 65 percent of participants who were asked to generate novel animals, tools, fruit, and rituals reported that they based their creations, at least in part, on specific known instances from those domains, such as dogs, hammers, oranges, and wedding ceremonies (Ward et al., 2002; Wruck, 2001). Participants who did not mention relying on specific instances reported a variety of strategies that generally involved a consideration of more abstract information, such as the properties an animal or fruit might need to survive on a planet that has certain environmental characteristics.

Differences in the type of information accessed (specific exemplars vs. more abstract principles) are important because they indicate different ways of formulating or defining the generation task, and because they are related to the novelty of the creations produced. That is, the majority seems to define the goal as something akin to imagining what a “space dog” or a “space orange” would look like, whereas a minority formulate it as envisioning “the kind of thing that might exist on a planet with certain environmental conditions.” Importantly, individuals who adopt the former goal generate ideas that are rated as lower in originality than those who choose the latter (Ward, 1994; Ward et al., 2002), presumably because the properties of individual exemplars (e.g., dogs) are more specific and constraining than the properties associated with higher levels of abstraction (e.g., two eyes symmetrically placed in the head vs. some sort of organs for sensing environmental conditions). For example, the more abstract property of “sensing conditions” affords a greater range of possibilities (beyond symmetrically located eyes) for the information being sensed and the organs through which that sensing occurs.

Stemming from the seminal efforts of Csikszentmihalyi and Getzels (1971) models of creativity have emphasized the importance of problem formulation or definition processes and their influence on the likelihood of achieving original or creative solutions (see e.g., Basadur, 1994; 1997; Mumford, Mobley, Uhlman, Reiter-Palmon, & Doares, 1991; Runco & Chand, 1994, 1995; Sternberg, 1988; Treffinger, Isaksen, & Dorval, 1994). The results from our creative generation studies showing a link between reported approaches and the originality of outcomes are consistent with that view. More abstract problem formulations do seem to allow more originality.

The literature on problem formulation also reveals that approaches are malleable, and that encouraging more effective problem formulations can lead to increased originality. Mumford, Reiter-Palmon, and Redmond (1994), for example, had college students develop a marketing survey and advertisements for a fictitious product, a 3-D television. Some of the students were pushed in the direction of problem construction through instructions to list the important factors to consider and to restate the problem prior to engaging in the generation task. Others were given no special instructions. The results showed that students given the problem construction boost produced ideas that were higher in quality and originality than those produced by the uninstructed students.

Baughman and Mumford (1995) also showed that when people were asked to combine exemplars from separate categories to form a single inclusive category, greater originality was observed when they were instructed to list features of category members and assess the commonalities and differences in features across the categories. Listing features and mapping feature relations across categories can be seen as a kind of abstraction or going beyond the properties of individual exemplars. Thus, the results mesh nicely with the observation that abstract approaches to generating imaginary entities are associated with higher rated originality of those entities (Ward, 1994; Ward et al., 2002).

Consistent with the findings of Mumford and his colleagues (XXXX), the path-of-least-resistance model views the differences in reported approaches in our generation tasks as strategic choices that are open to experimental manipulation. In this project, we conducted three experiments in which we attempted to influence the way in which people interpreted the generation task. The experiments tested the hypothesis that people can be induced to develop more novel products if they are given instructions that emphasize an abstract formulation of the task, and conversely, that they can be pushed in the direction of reduced novelty by instructions that emphasize specificity.

Experiment 1

In the first experiment, people imagined extraterrestrial animals under conditions that encouraged them either to think of specific Earth animals as models or to think of planetary conditions and what properties an animal would need to survive in those conditions. Based on the patterns of individual differences we have observed, the latter approach was expected to result in the generation of creatures that were relatively more unusual in the sense that they deviated more from properties of known Earth animals. That is, we expected a convergence between findings from studies that simply observed existing differences in approaches (Ward, 1994; Ward et al., 2002), and the studies that attempted to manipulate approaches via an instructional manipulation (see, e.g., Runco & Sakamoto, 1999).

Although the task does not require people to develop extensive accounts of all the attributes, social conventions, and interpersonal functioning of the creatures, it nevertheless requires the development of an candidate idea for an alien, and thus approximates an initial idea generation activity that might be performed by a science fiction writer. Interestingly, the instructions to consider planetary conditions also are similar to the world-building approach advocated by science fiction authors as a way to creatively generate novel aliens by first thinking about the planet and then envisioning what creatures would need to be like to survive there (e.g., Clement, 1991). Thus, the study can also provide evidence relevant to such practical suggestions.

Method

Participants. The participants were 87 undergraduates enrolled in introductory psychology classes who received experimental credit for their participation. All participants gave informed consent prior to their participation and were debriefed regarding the purposes of the study.

Procedure. Participants were tested in groups of 3 to 5 individuals, and were randomly assigned to one of two conditions. All participants were asked to imagine a planet somewhere in the universe that was very different from Earth, to imagine an animal that might live there, and to draw front and side views of their creation. Front and side views were requested because together they help to provide disambiguating information on properties such as bilateral symmetry as well as numbers of appendages, etc. Forty-three participants were asked to try to think of specific Earth animals, and to use them in imagining what the animal on the other planet would be like (*Exemplar* condition). The other 44 were asked to first think of exactly what the environment on the other planet would be like, and to consider what attributes their imagined animal would need to adapt to that environment (*Environment* condition).

When the drawings were completed, participants labeled all of the significant parts of their creations. Their drawings were then collected, and they responded to an open-ended question about how they had developed their creatures. The question was written to encourage participants to report all sources of information that had influenced their creations.

Coding. Two coders examined each participant's labeled drawing for the presence of standard Earth animal attributes, including the number of arms, legs, wings, eyes, ears, noses, and mouths, as well as for bilateral symmetry. They also examined the drawings for any unusual variations on the appendages or sense organs. Appendages were considered unusual if there was an atypical number of any major appendage (e.g., three legs), an atypical use for an appendage (e.g., absorbing nutrients through the feet), of if the creature had an appendage not characteristically found on typical earth animals (e.g., wheels). Senses were considered unusual if there was an atypical number of any major sense organ (e.g., one eye), an odd arrangement of the senses (e.g., mouth above the eyes), an unusual sensory ability (e.g., ability to hear up to 30 miles away), or if the creature had a sense organ not normally found on typical earth animals (e.g., telepathic receptors). Coders examined participants' statements about their approaches separately from the drawings and noted whether or not they included references to specific Earth animals as starting points (e.g., dogs, elephants) or a consideration of the environment to which the creature needed to adapt. The coders achieved a minimum of 90 percent agreement across the properties examined. In addition to rating each creation on these categorical variables, coders rated the "unusualness" of the creature on a 7-point scale, with higher numbers reflecting greater differences from typical earth animals. The intercoder correlation for these scores was .78. Finally, the coding data were used to develop a "difference" score, which was intended to reflect the number of major differences that existed between the imagined creature and typical Earth animals. Creations received one point for each of the following: asymmetry, no major appendages, no major senses, unusual appendages, and unusual senses. For example, a participant who developed an asymmetric creature that had no legs, arms, wings, eyes, ears, nose, or mouth, but that had wheels for movement and feelers to detect the emotional state of its prey would receive a difference score of 5.

Results

The instructional manipulation was effective in influencing the properties of participants' imagined animals in several ways, including the tendency to introduce novel variations on the senses and appendages, the tendency to incorporate standard sense organs and appendages, and the overall deviation of the imagined creatures from the properties of Earth animals. The participants in the Environment condition were significantly more likely than those in the Exemplar condition to include in their creations an unusual variation on the senses (43% vs. 21%), χ^2 (1, $N = 87$) = 4.93, $p < .05$, and an unusual variation on the appendages (36% vs. 12%), χ^2 (1, $N = 87$) = 7.27, $p < .01$. They were also significantly less likely than those in the Exemplar condition to endow their extraterrestrials with the standard Earth animal properties of eyes (84 vs. 100), χ^2 (1, $N = 87$) = 7.44, $p < .01$, ears (50 vs. 79), χ^2 (1, $N = 87$) = 8.01, $p < .01$, noses (70 vs. 88), χ^2 (1, $N = 87$) = 4.25, $p < .05$, and legs (79 vs. 98), χ^2 (1, $N = 87$) = 7.03, $p < .05$. In addition, mean difference scores were significantly higher for creatures from the Environment condition (.93) than for those from the Exemplar condition (.39), $F(1, 85) = 8.43$, $p < .01$. The same pattern held true for rated originality (3.38 vs. 2.77), and the difference was marginally significant, $F(1, 85) = 3.57$, $p < .062$. It appears then, that when people are instructed adopt a more abstract approach, they generate new ideas that possess a greater degree of novelty or unusualness.

An examination of people's reported approaches was also consistent with expectations. Of those in the Exemplar condition, the percentages whose statements included references to specific Earth animals, environmental conditions, both, or neither were 49, 5, 33, and 14, respectively. The corresponding percentages for those in the Environment condition were 9, 52, 30, and 9. This distribution of reported approaches across conditions deviates significantly from chance, χ^2 (3, $N = 87$) = 29.63, $p < .01$, and indicates that, at least from self-reports, people did respond appropriately to the instructions.

The cleanest comparison of the relation between reported approaches and the properties of the creations is between those whose statements of approach included references to Earth animals but not the environment and those whose statements mentioned the environment but not specific Earth animals. Collapsing across instructional conditions, the latter were more likely to introduce novel variations on the senses (52% vs. 24% of the creations), χ^2 (1, $N = 50$) = 4.16, $p < .05$, and they had significantly higher difference scores (1.04 versus .44), $F(1, 48) = 5.52$, $p < .05$. Thus, it appears that instructions to consider the environment in which a creature would live led to more abstract ways of formulating the task, which in turn were associated with more novelty in the created product.

Experiment 2

In the second experiment, we attempted to induce a more abstract conceptualization of the task through a different procedure than in the first experiment. Rather than being asked to consider the planetary conditions, some of the participants were asked to think about fundamental properties that could reasonably be expected to be true of animals in general and to consider how those properties might be instantiated in their own imaginary extraterrestrial. As in the first experiment, other participants were asked to think of specific Earth animals, and a third group received no special instructions. Again, the more abstract approach was expected to lead to more abstract problem formulation, and consequently to more deviation from Earth animal properties.

Method

Participants. The participants were 284 college students who received experimental credit for their participation. As in the first experiment, they gave informed consent prior to participation and received debriefing information afterward.

Procedure. Participants developed, drew, and described ideas for things that might live on planets different from Earth in one of three conditions. Ninety-four participants were in the Exemplar condition, in which they were asked to try to think of specific exemplars of Earth animals and to pattern their creations after those exemplars. Ninety-five were in the *Abstract Principles* condition, in which they were asked to avoid thinking about specific category exemplars, and to concentrate instead on higher order principles associated with the survival of life forms. They were asked to consider that living things must satisfy the following goals to survive: sense conditions in their environments, acquire nutrition to support biological processes, protect themselves from dangers, and reproduce. Ninety-five participants in a Control condition received no special instructions about how to develop their novel creations. After turning in their drawings, participants wrote responses to an open ended question concerned with the factors that had influenced them during the development of their ideas.

Coding. The drawings and statements were coded as described in the first experiment. Coders achieved a minimum percent agreement of 90 percent on the coded properties and a correlation of .82 between their novelty ratings.

Results

As can be seen in Table 1, the data bore out the expectation that participants in the Abstract Principles condition would develop the most novel products. Consistent with the pattern found in the first experiment, there were significant differences across the groups in the likelihood of including some novel variation on the senses, with the most and least occurring in the Abstract and Exemplar conditions, respectively, χ^2 (2, N = 284) = 18.41, $p < .001$. The same trend was observed for novel variations on the appendages, though it fell well below the level of significance, χ^2 (2, N = 284) = 1.38, $p > .50$. Also paralleling the findings of Experiment 1, there were significant differences across the groups in the likelihood of including ears, χ^2 (2, N = 284) = 9.25, $p < .05$, and legs, χ^2 (2, N = 284) = 6.32, $p < .05$, with the lowest percentages being included in the Abstract condition and the highest in the Exemplar condition. The percentages including eyes were high, fell within a narrow range, and did not differ significantly across the conditions, χ^2 (2, N = 284) = 5.79, $p > .05$. Oddly, arms were less prevalent in the Exemplar condition and more prevalent in the Abstract condition, χ^2 (2, N = 284) = 9.08, $p < .05$. As arms are considerably less typical than legs across all Earth animals, it is unclear how to interpret the greater use of arms by those in the Abstract condition, but it is not necessarily an indicator that their creations were more like Earth animals in general than those produced by people in the Exemplar condition. Indeed, consistent with the first experiment, there was a significant difference in mean difference scores across the conditions, $F(2, 281) = 6.92$, $p < .01$, with the lowest score being in the Specific condition and the highest in the Abstract condition. A similar finding occurred for mean novelty ratings, $F(2, 281) = 7.83$, $p < .01$.

Table 1. *Percentages of Properties, Difference Scores, and Novelty Ratings Across the Conditions*

	Attribute, Score, or Rating							
Condition	Novel Sensory (%)	Novel Appendages (%)	Eyes (%)	Ears (%)	Arms (%)	Legs (%)	Diff. Score	Novelty Rating
Exemplar	35	31	96	66	33	88	.79	2.52
Control	50	36	87	47	44	84	1.19	3.00
Abstract	66	39	95	46	55	74	1.35	3.54

As in Experiment 1, reported approaches to the task also varied systematically across the conditions, with a greater emphasis on specific Earth animals in the Exemplar condition and a greater emphasis on the adaptive survival needs of the creature in the Abstract condition. In the Exemplar condition, the percentage of participants who mentioned specific Earth animals, a consideration of survival needs, both or neither was 26, 15, 51, and 9 respectively. Corresponding percentages for those in the Abstract condition were 7, 45, 40, and 7, and for those in the Control condition were 16, 37, 26 and 21, respectively. The distribution of approaches across conditions differed from what would be expected by chance alone, χ^2 (6, N = 284) = 40.27, $p < .01$, with the pattern indicating that the instructions influenced participants' approaches in the expected direction.

Collapsing across conditions, those whose statements included references to abstract survival needs but not to specific Earth animals were more likely than those who mentioned Earth animals but not survival needs to include novel variations on the senses (63% vs. 24%), χ^2 (1, N = 138) = 18.78, $p < .01$, and appendages (42% vs. 22%), χ^2 (1, N = 138) = 5.71, $p < .05$. They also had significantly higher difference scores (1.38 versus .61), F(1, 136) = 18.73, $p < .01$, and significantly higher novelty rating scores (3.56 vs. 2.28), F(1, 136) = 16.50, $p < .01$. As in Experiment 1, then, more purely abstract approaches appear to lead to more novelty in imagined products than do more purely specific, exemplar approaches.

Experiment 3

A third experiment also tested participants in Exemplar, Abstract, and Control conditions, but added another factor: a description of the planet on which the creature was supposed to live. The reason for including this manipulation was so that we could take into account not just novelty, but also appropriateness of the variations people introduced into their creatures.

Method

Participants. The participants were 184 students enrolled in introductory psychology classes who received experimental credit for their participation. As in the first two experiments, they gave informed consent prior to participation and were debriefed afterward.

Procedure. All participants were asked to imagine, draw and describe a living thing that might exist on a planet different from Earth. Sixty-one were given Exemplar instructions, 61 were given Abstract principles instructions, and 62 were given Control instructions as described for Experiment 2. Within each of those groups, approximately half of the participants were told that the planet was very close to its sun and was extremely bright, hot, and dry, whereas the others were told that it was far from its sun and was extremely dark, cold, and snowy.

Coding. Coding proceeded as described in the first two studies, with one exception. Instead of tallying all variations on the senses and appendages, coders tallied major variations to the senses and appendages that could be reasonably interpreted as adaptive for the type of planet on which the animal lived. As in previous studies, coder agreement on categorical variables was 90 percent or better, and the correlation between originality ratings was .87.

Results

There were significant differences across the Exemplar, Abstract, and Control conditions in the likelihood of including major sensory adaptations, χ^2 (2, N = 184) = 8.77, $p < .01$, with the most occurring in the Abstract condition and fewer in the Control and Exemplar conditions, which differed only slightly from one another (see Table 2). Although the same pattern held for the likelihood of including major adaptations to the appendages, the difference across conditions was not significant χ^2 (2, 184) = 3.65, $p > .15$. The specific adaptations varied across the planet conditions, but the overall tendency to include sensory or appendage adaptations did not, $\chi^2 < 1$ in both cases.

As can be seen in Table 2, there were no differences in the tendency to include the specific Earth animal properties of arms or legs, $\chi^2 < 1$ in both cases. However, there was a significant difference in the tendency to include eyes, χ^2 (2, 184) = 6.21, $p < .05$,

Table 2. *Percentages of Properties, Difference Scores, and Novelty Ratings Across the Conditions*

	Attribute, Score, or Rating							
Condition	Major Sensory Adaptation (%)	Major Appendage Adaptation (%)	Eyes (%)	Ears (%)	Arms (%)	Legs (%)	Diff. Score	Novelty Rating
Exemplar	31	23	90	56	25	92	.66	3.12
Control	29	23	86	48	23	89	.71	3.69
Abstract	52	36	74	47	23	89	1.16	4.64

with the most occurring in the Exemplar condition and the fewest in the Abstract condition, and a similar, though not significant trend for ears, $\chi^2 < 1$. Not shown in Table 2 is the fact that there was a similar and significant trend for including noses (74%, 71%, and 53% of the creations in the Exemplar, Control, and Abstract conditions, respectively), χ^2 (2, 184) = 7.28, $p < .05$. So the trend across the specific senses and appendages is for greater deviation in the Abstract condition relative to the others. Consistent with these observations, difference scores differed significantly across conditions, $F(2, 178) = 4.96$, $p < .01$, as did rated novelty scores, $F(2, 178) = 9.14$, $p < .01$, with the highest scores being in the Abstract condition and the lowest being in the Exemplar condition (see Table 2). Neither the difference scores nor rated novelty scores differed significantly across the planet types, $F < 1$, and $F(1, 182) = 1.65$, $p > .20$.

Reported approaches varied significantly across the conditions, χ^2 (6, N = 184) = 44.65, $p < .01$, with the percentage mentioning Earth exemplars, survival needs, both or neither being 33, 13, 52, and 2 in the Exemplar condition, 10, 48, 34, and 8 in the Control condition, and 0, 53, 41 and 7 in the Abstract condition. The creatures generated by those who reported more purely abstract, survival approaches had higher difference scores (1.04 vs. .58) and rated novelty scores (4.61 vs. 2.42) than those developed by people reporting more purely Earth exemplar approaches. The former was marginally significant, $F(1, 94) = 3.68$, $p = .058$, and the latter was significant, $F(1, 94) = 26.17$, $p < .01$. As in the previous experiments, it appears that adopting a more abstract conceptualization of the task of creative generation leads to higher levels of originality, including the introduction of appropriate novel sensory variations.

Discussion

These findings show that the way in which people approach creative generation tasks is malleable. They can be induced to adopt approaches that are relatively more abstract or more specific in character, and their creations become more or less novel as a result. People instructed to consider how a creature would fit into an environment or meet survival goals created imaginary extraterrestrials that were more original or novel than those developed by people given no special instructions or asked to think of specific Earth animal exemplars. The effects were seen in a greater tendency to include novel variations on the senses or appendages, a reduced likelihood of carrying over typical Earth animal senses and appendages to the new creation, and more overall deviation from Earth animals as indicated by difference scores and ratings of novelty. It is also important that in the third study, people were given different types of planets to consider, and the novel variations they included were appropriate to the conditions on those planets.

The results are consistent with, but also extend and clarify, previous conceptual expansion findings. In earlier studies, it was shown that the majority of participants access and rely on specific known exemplars in creating their new ideas, whereas a minority consult more abstract kinds of information, and that the latter develop products that are more novel or original (Ward, 1994; Ward et al., 2002). The present results showing a link between instructions, reported approaches, and the novelty of the creations confirm these earlier observations, but highlight that they are not based on rigid constraints or fixed individual differences in generative processing ability. Rather, the tendency to rely on specific exemplars is a strategy that can be altered by instructions that encourage people to formulate the creative generation problem at a more abstract level.

In a more general sense, the findings are also consistent with models that emphasize the role of problem formulation or definition processes and their impact on creative outcomes (e.g., Basadur, 1994; Baughman & Mumford, 1995; 1997; Mumford et al., 1991; Runco & Chand, 1994; 1995; Runco & Sakamoto, 1999; Sternberg, 1988; Treffinger et al., 1994), and with previous results showing that more effective problem formulation can be induced and will result in more original outcomes. They also highlight that one path by which different problem formulations have their effect is through the retrieval of different types of information.

If people think of their task as one of envisioning variations on specific Earth animals for other planets (e.g., a Martian elephant), they will tend to retrieve specific animals as a starting point. Having brought those exemplars to mind, they can reasonably be expected to project their properties onto the novel creations with the consequence that the creations will strongly resemble those particular Earth animals (i.e., display limited novelty or originality). In contrast, if people conceptualize the task as the more general one of considering what properties an organism might need to survive in a particular environment they will tend to retrieve more general types of information. Because stored properties at higher levels of abstraction would be less specific and constraining and allow a wider range of possible instantiation (e.g., generic sense organs vs. two eyes symmetrically placed in the head), more original products would be expected to result when people access knowledge in these more abstract ways.

Caution is necessary in interpreting these results because they are based on a relatively brief laboratory task with a college student sample. Nevertheless, the findings on inducing abstract approaches may have implications for improving creative outcomes in applied settings. For one thing, they provide experimental evidence in support of the creative wisdom offered by science fiction authors. The Environment condition of Experiment 1, for example, is similar to Clement's (1991) "world-building" approach, in which he considers the nature of the planet first and then dreams up alien life forms that could survive in those planetary conditions. The Abstract Principles condition of Experiments 2 and 3 resembles an approach advocated by Ochoa and Osier (1993), in which the would-be alien creator is supposed to list central properties of Earth animals and consider variations on them.

The fact that the novel variations in Experiment 3 were appropriate to the setting of the described planet also suggests that the findings have implications for improving creative functioning in domains in which originality and functionality are equally important. For example, design engineers are often claimed to pattern new devices after readily accessible instances of earlier solutions, which can lead them to craft nonoptimal designs (Jansson, Condoor, & Brock, 1993). More abstract approaches may help them to innovate without sacrificing functionality. Similarly, entrepreneurs must craft ideas for business ventures that are new, but also workable (see e.g., Baron, 2000), and a more abstract approach to idea generation may help them accomplish both goals (Ward, in press).

It is important to note, however, that there is nothing wrong, in principle, with the approach of retrieving a specific known instance of a category or a specific previous problem solution as a way of gaining some purchase on a new problem. Indeed, there may be circumstances under which it is preferable to a more abstract approach, as when the creative goal is one of making a relatively smaller advance (see, e.g., Sternberg, 1999; Sternberg, Kaufman, & Pretz, 2001). For one thing, it can be highly efficient and lead to the rapid development of new products. If a perfectly good model already exists, then using it and modifying it only slightly may be the most expedient and appropriate course of action. It might also help to make new products more acceptable to their target audience by keeping them from deviating too far from the familiar. An extraterrestrial that deviated greatly from known Earth animals might not be recognized as an animal at all, and by analogy, a new product that deviated too greatly from other members of its product class might not be accepted by consumers at all.

The problem of relying on specific known instances becomes apparent primarily when properties of those instances unnecessarily constrain the form of the new idea. Barker (1993), for example, has claimed that the Sony Corporation temporarily abandoned their initial efforts to develop music CDs because they were using LP record albums as their starting model, and a CD of that diameter would presumably hold a commercially nonviable 18 hours of music. Another example of the same phenomenon is that railway passenger cars were initially patterned directly after stagecoaches, including external seating for the conductor, with dangerous and even deadly consequences for the conductors who fell from the vehicles (see e.g., Ward, 1995). Our results suggest that one possible means of overcoming such constraints is for new product designers to formulate their problems more abstractly and access more general types of principles rather than specific known domain instances.

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