

## **Dissimilarity in Creative Categorization**

Apara Ranjan and Narayanan Srinivasan

Centre of Behavioural and Cognitive Sciences

University of Allahabad, Allahabad

Corresponding Author:

Dr. Narayanan Srinivasan

Centre of Behavioural and Cognitive Sciences

University of Allahabad

Allahabad 211002, India

Phone: 915322460738

Email: [nsrini@cbcs.ac.in](mailto:nsrini@cbcs.ac.in)

## **Abstract**

Theories of categorization need to account for ways in which people use their creativity to categorize things especially in the context of similarity. The current three-phase study is a preliminary attempt to understand how people group concepts together as well as to explore the role of similarity between concepts in creative categorization. Participants were asked to categorize a list of 100 words and the resulting categories were rated for creativity by another set of participants. In the last phase, similarity between words from all the categories was computed using latent semantic analysis. There was a significant correlation between similarity values and creativity ratings for all the categories. In addition a new set of participants were asked to rate the similarity among the words in the least and most creative categories and there was a significant difference between the mean ratings of the two types of categories. The results indicate that creative categorization is characterized by grouping of dissimilar words. People use creative imagination to construct novel categories by linking apparently dissimilar words.

**Keywords:** Creativity; Categorization; Similarity

## **Introduction**

Creativity has often been regarded as a process or aspect associated with novelty, originality and thinking out of the box. Breaking the regular mental set in thinking to come up with an optimal solution for a problem is termed as a creative solution to a problem or insight. Various historical studies of creativity done on artists and scientist have indicated that the linkage of previously unrelated concepts often laid the groundwork for creative achievements (Kuhn 1970; Rothenberg 1986; Weber 1992). Recent research on creativity based on the creative cognition approach has emphasized creativity as emerging from everyday cognitive processes like perception, attention, concept formation, categorization and problem solving that are applied to knowledge structures leading to the creation of novel ideas (Ward, 2007).

Out of the myriad cognitive processes that help us think and solve day-to-day problems, categorization of concepts plays an important role. Understanding categorization is important for understanding creative cognition (Ward, 2007). Categorization is a dynamic process in which we continue to add, subtract, and modify our conceptual domains in various ways based on our experience. Continual growth of categorical and conceptual knowledge due to the restructuring of concepts is in itself a creative phenomenon (Ward, Smith, & Vaid, 1997). The process of categorization is a complex phenomenon consisting of learning new categories, retaining already learned categories, and interaction of old and new category structures at different levels of abstraction. This is achieved by combining as well restructuring different concepts (Mumford, Mobley, Uhlma, Reiter-Palmon, & Doares, 1991).

Both creative and non-creative categories arise out of everyday categorization (Perkins, 1981; Ward, 1994; Weber & Dixon, 1989; Weisberg, 1988). Given the diversity of the stimuli in our natural environment, people regularly construct, stretch, extend, modify, and refine single concepts to fit new situations (Ward, Smith, & Vaid, 1997). However, creative thinking may enhance the production of original or novel categories that brings out or emphasizes less obvious meanings of a given concept. People who make sensible combinations of words that do not have overlapping properties tend to be creative and even while interpreting such combinations come up with emergent properties (Hampton, 1997; Wilkenfeld & Ward, 2001). Previous studies by Mumford and his colleagues (Baughman & Mumford, 1995; Mobley, Doares, & Mumford, 1992) have shown that people asked to reorganize and combine diverse categories come up with more original products than when they are asked to work with similar categories. However, little is known about what makes an individual category creative.

Many models explain categorization in terms of similarity (Goldstone, 1994; Medin & Schaffer, 1978; Nosofsky, 1986; Wisniewski, 2002). However, similarity-based accounts fail to explain a number of findings on categorization (Murphy & Medin, 1985; Rips, 1989; Spalding & Murphy, 1996). Murphy and Medin (1985) have argued for a theory-based account of categorization in which knowledge about concepts plays a critical role in categorization. The mental structures that determine categorization are naïve theories of causal relatedness of various properties influencing conceptual structure and use. The problem with similarity-based theories is the lack of sufficient constraints to determine what constitutes a relevant feature for a category.

Similarity is also context specific (Goodman, 1972). In the context of hair, gray is more similar to white than to black, but in the context of clouds, gray is more similar to black than to white (Medin & Shoben, 1988). While evaluating attributes and forming categories, we do not consider all the attributes but only those that are relevant or salient in a given context. The categorization of a given concept depends on the other concepts that are already in the category and this interaction between concepts results in a process of categorization that is dynamic and goal-dependent (Barsalou, 1983, 1991; Barsalou & Medin, 1986). While similarity is important, the computation of similarity itself is flexible depending on the context, goal and the instances that are being compared. The context-sensitivity of similarity might result in the combination of concepts that might be considered unrelated to each other in a context independent scenario leading to the emergence of new categories that could be considered creative.

When we create a new member of a known category for an imaginary setting, for example, an animal (known category) living on a different planet (imaginary setting) our imagination is structured by a specific set of properties that are characteristics of that category (Ward, 1994). We might not be able to resist the tendency to use specific basic level exemplars from that domain as a starting point. The stored properties of the basic level exemplars are projected on to the ideas being developed (Ward, 1994; Ward, 1995; Ward, Dodds, and Saunders, & Sifonis, 2000). Studies have also shown that we construct ad hoc categories on the spot, as we need them (Barsalou, 1983; 1991). This aspect of categorization provides more scope for flexible cognitive processing and is crucial for capturing the creative thought processes. In spite of numerous constraints, human cognition entertains avenues of emergence and novelty based on theories formed by effective interaction and

information from multiple domains. Consistent with these ideas, people asked to combine related and unrelated categories followed by the generation of exemplars from the resultant category produced a larger number of novel exemplars with unrelated category combinations (Baughman & Mumford, 1995; Mobley, Doares, & Mumford, 1992)

Typically, in most of the categorization experiments, the experimenter fixes the number of possible categories (Medin, Wattenmaker, & Hampson, 1987) or participants are made to learn pre-defined categories. Restricting the possible ways of categorization might act as a constraint and not leave enough room for originality and interesting combinations in categorization, which might be dissimilar. In order to capture the creative aspect of the process we need to leave open the possibility of novelty. The creative aspects of categorization need to be understood and the current study is an attempt to see whether creativity emerges in the process when people categorize without having any pre-defined goal or category sets, and they are left free to interact with different concepts.

In the current study, we focus on creative categorization and specifically explore the role of (dis)similarity in creative categorization. Minimal constraints are imposed so that some of the categories might turn out to be creative. Given that most categories consist of similar instances, we hypothesized that categories consisting of dissimilar instances would be perceived as more creative. The study consisted of three phases: categorization, selection of categories based on their creativity and similarity ratings between concepts in a given category.

### **Phase One: Categorization**

The purpose of this phase was to enable people to categorize with minimal constraints and to study various aspects of the resultant categorizations. Getzels and Csikszentmihalyi (1976) found that artists came up with better creative productions when they did not start with a pre-defined plan in mind but were concerned with exploring and discovering emergent structures and forms. The opportunity for flexible manipulations of conceptual representations could be important for creative production of categories. More specifically, we wanted to look at the relationships between concepts within a given category without imposing any constraints on the number of categories as well as number of items within a category. Words used for categorization were randomly generated (trans-domain) and there were no experimenter-defined categories.

## **Method**

### *Participants*

Ten volunteers from Allahabad fluent in English (English is their second language but their school and college education is through English) participated in the experiment. Information about their education was obtained and all the participants had undergone college education and had obtained an undergraduate degree. They also rated their proficiency in English (reading, writing, and speaking) on a five-point scale. The mean proficiency of all the participants was 4.3 on a five-point scale.

### *Stimuli*

A list of 100 words (nouns) was created by arbitrarily picking words from different domains using a set of frequently used words. The mean word frequency of the words was 85.1 with a large number of high frequency words and a small number of low

frequency words. The word frequency was obtained from the MRC linguistic database. The selected list of words (see Table 1) printed on paper was then presented to the participants. Sufficient extra sheets of paper and writing material were provided for the task of categorizing the words.

### *Procedure*

Participants were asked to form categories with the words. The number of elements in each category as well as number of categories was left open to the participants and was not constrained. The participants were asked to give a name and definition for all the created categories. The definition given by the participants helped us to understand the basic idea behind grouping certain words together, especially when categories formed were not obvious. The participants were given one hour to complete the task.

### **Results and Discussion**

The number of categories was different for each participant. A total number of 105 categories were created by the participants. Data from one participant was not included for further analysis, as the participant could not complete the categorization task in the allotted time. On an average, each person came up with twelve categories and each category contained eight words. Most of the categories had elements within the range of 3 to 9. There were very few categories with more than 13 concepts. Many categories were common among the participants (e.g. computers, theatre, and political system). However, there were no categories with the same set of elements, formed by the participants, though few of the elements were common in some categories. It was observed that most of the category names were from already existing domains like

science, music and politics. Words appeared in different categories with different participants. This indicates that categorizing a particular word in a specific category was not just based on the similarity of features or exemplar based. Instead, this hints that people do use their creative imagination to select appropriate relationships among concepts. Given the possible use of creative insightful processes in categorization, the next phase was conducted to determine the creative nature of the categories.

### **Phase Two: Selection of most creative and least creative categories**

The main purpose of this phase was to identify the most creative and least creative categories among the 105 categories formed by the participants in the first phase. This was necessary to explore the basic characteristics of the most creative and the least creative categories.

### **Method**

#### *Participants*

Forty five volunteers with mean age of thirty five years and fluent in English participated in the experiment. Information about their education was obtained and all the participants had at least completed an undergraduate degree. They also rated their proficiency in English (reading, writing and speaking) on a five-point scale. The mean proficiency of all the participants was 4.4 on a five-point scale.

#### *Stimuli*

All the categories from a participant in the previous phase with name and definition along with the words under that particular category were printed on separate sheet and given for creativity ratings.

### *Procedure*

All the categories formed by each of the participants in first phase were given to five participants in phase two. Participants were asked to rate the creativity of the categorization for each category on a seven point Likert-type scale with one indicating least creative category and seven indicating most creative category. A total of forty five participants rated all the categories created by the nine participants in the first phase. No specific guidelines were given to the raters regarding the definition of a creative category. This was done to ensure minimal bias among the participants in terms of what is creative or not and let them follow their own individual ideas on what constitutes a creative category. We did not ask participants to rate the creative nature of all the categories since many categories had similar names but different sets of elements, multiple groupings of same set of elements and also a large number of categories (105 in total).

### **Results and Discussion**

Participant's ratings were used to select the nine most creative categories and nine least creative categories among the 105 categories. The least creative categories (mean ratings lower than 2.8) and the most creative categories (mean ratings higher than 6.6) along with their mean creativity ratings are shown in Table 2. Five raters rated all the categories generated by a participant from the previous phase and we computed the inter rate reliability for the five raters. There were a total of nine groups

with five raters each with each group of raters rating a set of categories produced by a participant in the previous phase. We computed the inter rater reliability for each group of five raters and then computed the mean inter rater reliability of all the groups of raters to give an estimate inter rater reliability. The inter rater reliability (Ebel, 1951) for all the categories and raters put together was 0.58<sup>1</sup>. The inter rater reliability computed only for the most creative and least creative categories was 0.94 indicating that there is considerable agreement between raters when it comes to the least and most creative categories.

One interesting result is the presence of two categorizations with the same name category i.e.; 'computers' with one categorization rated most creative and another categorization rated least creative. (See Table 3 for concepts listed for the two different categorizations of computers) This shows that ratings given by the participants were based mainly on the bases of elements assigned to a particular category contained rather than simply basing it on the name of the category. The mean number of items in the most creative categories and least creative categories was 8.44 and 4.44 respectively.

The creation of categories was reasonably distributed among participants and no single participant created the majority of creative categories. Out of the nine most creative categories, three categories (*Related to truck driver's life*, *Space of religion and Politics*) was created by one participant. Out of the least creative categories, the same participant created four categories (Bulb, Entertainment, Account and Political system). These do point to potential individual differences in creative categorization that needs to be further explored. It is to be noted creativity was person specific. Among the most creative categories, twenty seven words were repeated and among the least creative categories, seven words were repeated. Repetition of words in the

creative categories clearly showed that different participants categorized the same word in different groups under different context. This indicates the crucial role-played by factors like contextual cues and background knowledge, other than feature coherence in human categorization. To understand the relationship between words in the most creative and least creative categories, the third phase was conducted.

### **Phase Three: Similarity of Concepts and Creative Categorization**

Earlier studies, done with conceptual combination show that combination of dissimilar concepts leads to more creative interpretations (have more emergent properties) than the conceptual combination of similar concepts (Wilkenfeld & Ward, 2001). The process of combining or categorizing concepts allows for enormous flexibility of thought. The purpose of this phase was to identify the potential role played by similarity in creative categorization.

Similarity between all the word pairs in a given category was computed using latent semantic analysis (LSA)<sup>2</sup>. The mean similarity of value of all the word-pairs was computed for a given category and correlation was performed with the creativity ratings obtained for each category from Phase 2. In addition, similarity ratings were obtained from human participants for all the pairs in the least and most creative categories to check whether the similarity measures would be different for the least and most creative categories.

## **Method**

### *Participants*

Ten volunteers with mean age of 35 years fluent in English participated in the experiment. Information about their education was obtained and all the participants had at least completed an undergraduate degree. They also rated their proficiency in English (reading, writing and speaking) on a five-point scale. The mean proficiency of all the participants was 4.4 on a five-point scale.

### *Stimuli*

Each individual word was paired with every other word within the category. Words within a category were not paired with words in another category for similarity ratings. Pairing the words within each category (nine creative and nine non-creative) resulted in a total of four hundred sixty nine word pairs. The word pairs were randomly arranged in a list and given to the participants.

### *Procedure*

Participants were asked to rate the similarity of words in each pair using a Likert type scale values ranged from one to seven with one indicating that the items were completely similar and seven indicating that they were completely dissimilar.

## **Results and Discussion**

Mean similarity values of all word pairs within a particular category were computed using LSA for all but one category, which contained compound words. The similarity values ranged from 0.03 to 0.62. There was a significant correlation between the similarity values obtained with the LSA and creativity scores from Phase 2,  $r = -0.36$ ,  $p = 0.0001$ . The results indicate a clear relationship between the similarity values and

creative nature of the category with lower similarity values being associated with higher creativity ratings.

In addition, participant's ratings were used to identify the amount of similarity or dissimilarity between the words in the most creative and least creative categories. The mean rating for all the pairs in each of the most creative categories and least creative categories was calculated for each of the ten subjects. A one variable ANOVA indicated a significant difference in similarity between the words of most creative categories and least creative categories  $F(1, 7) = 13.295, p < 0.05$ . The mean dissimilarity value for the most creative categories (4.16) was greater than that for the least creative categories (2.81). The inter-rater reliability value for the raters who performed similarity ratings was 0.8 indicating that the raters agreed with each other in terms of their conceptions of semantic similarity.

The results with LSA as well as similarity ratings from human participants clearly show that creative categories were constituted with more dissimilar words compared to least creative categories. People do use creative imagination to construct novel categories successfully linking words that are typically not associated with each other.

### **General Discussion**

Most theories of categorization consider the computation of similarity to be important for categorizing concepts. Empirical research on similarity indicates that there are multiple factors that might lead the people to maneuver the essence of similarity while forming categories. Barsalou (1983) describes "ad hoc" categories that collect apparently dissimilar elements into the same category to meet a goal. This process is

spontaneous since these categories are not stored in long term memory. Categorization of a given set of concepts is dependent on the relationships with other concepts and the contextual cues associated with those concepts. Categorization without any predefined goal and less constraints may expand the scope of associations and make people see relationships that are not beyond the similarity computations between concepts.

What are the factors that make a particular category creative? The results of the third phase clearly show that most creative categories consisted of dissimilar concepts and the least creative categories were consisted of similar concepts. The significant correlation between creativity ratings and the similarity values indicate the critical role that dissimilarity could play in creative categorization. In an early study of creativity and language, Rothenberg (1973) proposed that creativity might be linked to “Janusian thinking” which is defined as the ability to use two or more opposite or contradictory concepts simultaneously. Recent research on conceptual combinations (Estes & Ward, 2002; Wilkenfeld & Ward, 2001) have shown creative emergence of novel features in dissimilar conceptual combinations. Novel attributes emerge with conceptual combinations when dissimilar concepts are put together (Wilkenfeld & Ward, 2001). Atypicality leads to more emergent features with adjective-noun combinations (Estes & Ward, 2002). These findings from our study on the important potential link between dissimilarity and creativity are in agreement with other studies that have explored the role of similarity in creativity.

Participants categorized the same set of words differently given possible differences in their experience and domain knowledge. People’s decision to place a particular element in any category depends on the theory they have about the world (Komatsu, 1992). Studies have shown that manipulating participant’s theoretical

knowledge by explicitly giving some participants abstract description or background knowledge affects categorization. It clearly shows that categorizations are highly sensitive to the background theories provided (Ahn, 1991; Medin, Wattenmaker, & Hampton, 1997). It is interesting that even though the same set of concepts were given to all participants, none of the participants came up with the set of same categories. The theories that people have provide coherence to a category that is not provided by similarity.

Is there a relationship between the number of exemplars in a category and the creative nature of categories? With a smaller number of exemplars, concepts might be strongly constrained by similarity and might result in simple categorizations. With a larger number of exemplars, it might be possible for participants to see relationships that are not trivial and form creative categories. As the number of exemplars considered for a given category increases, people's knowledge about the relationship between individual exemplars provides constraints that form the basis of creative categorization. This will depend on processes including attention and working memory and further studies would be needed to understand these processes in seeing relationships between exemplars based on knowledge and goals, in modifying similarity computations themselves and in creating categories with a given number of exemplars.

The lack of order and flexibility in choosing concepts for categorization may have presented opportunities to the participants to see distant and non-obvious relationships that are not normally seen in a given situation. More than half of the categories got scores ranging from four to seven indicating the presence of creative aspects in categorization obtained with minimal constraints. Most of the 105 categories formed by the participants by the end of the first phase had category names

from already existing domains. However, even the typical categories consisted of different set of elements that may not be entirely obvious based on the given definition. Participants had also created non-obvious categories like “*Space of religion*” or “*Eyes of God*” with their own definitions.

A common aspect of creativity is generating novel instances from already existing conceptual domains. Mostly the categories formed by participants were not completely novel but associations drawn among the words within the categories were novel in some sense. Ward, Smith and Vaid (1997) have referred to ‘conceptual expansion’ that is pushing of boundaries of a given domain by mentally creating new exemplars and bringing those new ideas to fruition. Such ‘conceptual expansion’ might enable grouping of words that are normally considered dissimilar to each other. Putting things together which never or rarely have been think of together is commonly observed in use of metaphors and conceptual combinations.

Indurkha (1992) has talked about the emergent aspect of similarity when certain concepts are grouped together. He has argued that words like cats and fog seem to belong to a very different domain with no similarities between them, until one comes across Carl Sandburg’s poem in which they are paired together. Related is the concept of bisociation in which previously unrelated levels of experience or frames of references are suddenly connected (Kostler, 1964). The interaction of contrary patterns of thought or behavior may lead to creative innovations. This interaction might be significantly affected by personal experience and context provided by the group of concepts that are being considered for categorization. The current study clearly indicates the role of dissimilarity in creativity and further studies are needed to understand the role of other factors and the way they interact with dissimilarity in creative categorization.

## References

- Ahn, W. (1991). Effects of background knowledge on family resemblance sorting: Part II. *Proceedings of 13<sup>th</sup> Annual Conference of Cognitive science Society* (pp. 203-208). Hillsdale, NJ: Erlbaum
- Barsalou, L. W. (1983). Ad hoc categories. *Memory & Cognition, 11*, 211-227.
- Barsalou, L. W. (1991). Deriving categories to achieve goals. In G.H. Bower (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory*, Volume 27, ed. Bower, 1-64, San Diego, CA: Academic Press.
- Barsalou, L. W., & Medin, D. M. (1986). Concepts: static definitions or context-dependent representations? *Cahiers and Psychologie Cognitive, 6*, 187-202.
- Baughman, W. A., & Mumford, M. D. (1995). Process analytic models of creative capacities: Operations influencing the combination-and-reorganization process. *Creativity Research Journal, 8*, 37-62.
- Ebel, R. L. (1951). Estimation of the reliability of ratings. *Psychometrika, 16*, 407-424.
- Estes, Z., & Ward, T. B. (2002). The Emergence of Novel Attributes in Concept Modification. *Creativity Research Journal, 14*, 149-156.
- Getzels, J. W., & Csikszentmihalyi, M. (1976). *The Creative Vision: A Longitudinal Study of Problem Finding in Art*. New York: Wiley.
- Goldstone, R. L. (1994). The role of similarity in categorization: providing groundwork. *Cognition, 52*, 125-157.
- Goodman, N. (1972). Seven strictures on similarity. In N. Goodman (Ed.), *Problems and Projects*. New York: Bobbs-Merrill.
- Hampton, J. A. (1997). Emergent attributes in combined concepts. In T. B. Ward, S. M. Smith, & J. Vaid (Eds.), *Creative Thought: An Investigation of Conceptual*

- Structures and Processes* (pp. 83-110). Washington, DC: American Psychological Association.
- Indurkha, B. (1992). *Metaphor and Cognition*. Dordrecht: Kluwer.
- Koestler, A. (1964). *The Art of Creation*. New York: Macmillan.
- Komatsu, L. K. (1992). Recent views on conceptual structure. *Psychological Bulletin*, *112*, 500-526.
- Kuhn, T. S. (1970). *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
- Medin, D. L., & Schaffer, M. M. (1978). Context theory of classification. *Psychological Review*, *85*, 207-238.
- Medin, D. L. & Shoben, E. J. (1988). Context and structure in conceptual combination. *Cognitive Psychology*, *20*, 158-190.
- Medin, D. L., Wattenmaker, W. D., & Hampson, S. E. (1987). Family resemblance, conceptual cohesiveness, and category construction. *Cognitive Psychology*, *19*, 242-279.
- Mobley, M. I., Doares, L. M., & Mumford, M. D. (1992). Process analytic models of creative capacities: evidence for the combination and reorganization process. *Creativity Research Journal*, *5*, 125-155.
- Mumford, M. D., Mobley, M. I., Uhlman, C. E., Reiter-Palmon, R., Doares, L. M. (1991). Process analytic models of creative thought. *Creativity Research Journal*, *4*, 91-122.
- Mumford, M. D., Supinski, E. P., Threlfall, E. K., & Baughman, W. A. (1996). Process-based measures of creative problem-solving skills: III. Category selection. *Creativity Research Journal*, *9*, 395-406.

- Mumford, M. D., Baughman, W. A., Maher, M. A., Constanza, D. P., & Supinski, E. P. (1997). Process-based measures of creative problem-solving skills: IV. Category combination. *Creativity Research Journal, 10*, 59-71.
- Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*, 289-316.
- Nosofsky, R.M. (1986). Attention, Similarity, and the identification-categorization relationship. *Journal of Experimental Psychology: General, 115*, 39-57.
- Perkins, D. N. (1981). *The Mind's Best Work*. Cambridge, MA: Harvard University Press.
- Posner, M.I., & Keele, (1986). On the genesis of abstract ideas. *Journal of Experimental Psychology, 77*, 353-363.
- Rips, L. J. (1989). Similarity, typicality, and categorization. In S. Vosniadu & A. Ortony (Eds.), *Similarity, Analogy, and Thought* (pp. 21-59), Cambridge: Cambridge University Press.
- Rothenberg, A. (1973). Word association and creativity. *Psychological Reports, 33*, 3-12.
- Rothenberg, A. (1986). Artist creation as stimulated by super imposed versus combined composite visual images, *Journal of Personality and Social Psychology, 50*, 370-381
- Spalding, T.L and Murphy, G. L. (1996). Effects of background knowledge on category construction. *Journal of Experimental Psychology: Learning, Memory and Cognition, 22*, 525-538.
- Ward, T.B. (1994). Structured imagination: The role of category structure in exemplar generation. *Cognitive Psychology, 27*, 1-40.

- Ward, T.B., (1995). What's old about new ideas? In: Smith, S.M., Ward, T.B., Finke, R.A. (Eds.). *The Creative Cognition Approach*. MIT Press, Cambridge, MA, pp. 157–178.
- Ward, T.B. (2007). Creative cognition as a window on creativity. *Methods*, 42, 28-37.
- Ward, T.B., Smith, S. M., & Vaid, J. (1997). Conceptual structures and processes in creative thought. In T.B. Ward, S.M. Smith, & J. Vaid (Eds.) *Creative thought: An investigation of conceptual structures and processes* (pp. 1-27), Washington, DC: American Psychological Association Books.
- Ward, T. B., Dodds, R. A., Saunders, K. N., & Sifonis, C. M. (2000). Attribute centrality and imaginative thought. *Memory and Cognition*, 28, 1387-1397.
- Weber, R.J., (1992). Stone Age knife to Swiss army knife: An invention prototype. In R. J. Weber & D. N. Perkins (Eds.). *Inventive minds: Creativity in technology* (pp. 217-237), New York: Oxford University Press.
- Weber, R.J., & Dixon, S. (1989). Invention and gain analysis. *Cognitive Psychology*, 21, 238-302.
- Weisberg, R.W., (1988). Problem solving and creativity. In R.J Sternberg (Ed.), *The Nature of Creativity: Contemporary Psychological Perspective* (pp. 220-238). Cambridge: Cambridge University Press.
- Wilkenfeld, M.J., & Ward, T.B. (2001). Similarity and emergence in conceptual combination. *Journal of Memory and Cognition*, 45, 21-38.
- Wisniewski, E.J. (2002). Concepts and Categorization. In H. Pashler. & D. Medin (Eds.), *Stevens' Handbook of Experimental Psychology (3rd ed., Vol. 2: Memory and cognitive processes* (pp. 467-531), New York: Wiley.

## Footnotes

<sup>1</sup>Interreliability calculations were performed using the program at <http://www.med-ed-online.org/rating/reliability.html>.

<sup>2</sup>Latent semantic analysis was performed using the applications available at <http://lsa.colorado.edu/>.

## **Acknowledgments**

We thank Priya Srinivasan in helping us with data analysis.

## **List of Tables**

Table 1: List of 100 words

Table 2: List of nine least creative and nine most creative categories

Table 3: Categories with the same name but a different set of concepts

Table 1

stimulus	screen	dust	voice	file
truck	game	climax	community	fuse
labor	brush	sentence	parent	paradise
human	virus	evolution	movie	origin
witch	sword	justice	resource	program
function	master	phase	monitor	clone
hair	number	lungs	filament	Column
Politics	wheel	guitar	pager	bed
sheet	liberal	problem	campus	catalogue
string	stress	democracy	bench	paper
key	terror	fairy	journey	music
chat	judge	lesson	bank	stage
gender	bunch	wind	net	electron
respect	global	commerce	space	couch
strike	jail	robot	balance	toy
Temporal	note	post	light	mystery
breath	rumour	play	school	loop
air	dream	bulb	gay	shape
budget	memory	supervisor	motion	humour
order	strength	cable	religion	structure

Table 2

<b>Least Creative Categories</b>	<b>Most Creative Categories</b>
Electronics	Related to truck driver's life
Computer	One meaning led to other.
Entertainment	Supernatural/Spirituality
Political System	Politics
Account	Space of religion
Emotions	Eyes of God
Electrical Appliance	States of object or process or human
Size	Computer
Bulb	Intangible perception

Table 3

<b>Category Name</b>	<b>Elements of the category</b>
Computer (Most Creative Group)	Net, chat, virus, movie, key, stimulus, screen, note, monitor, pager, sheet, file, brush, program, bunch, number, column, cable, problem
Computer (Least Creative Group)	Net, virus, space, program, memory, loop, cable, key, monitor