
The Emergence of Novel Attributes in Concept Modification

Zachary Estes

University of Georgia

Thomas B. Ward

University of Alabama

ABSTRACT: An important source of creativity in concept combination is emergence: Novel features are often attributed to a concept combination that are not attributed to either of its constituent concepts. For instance, a Harvard-educated carpenter is judged to be nonmaterialistic, though neither Harvard-educated people nor carpenters in general are thought to be nonmaterialistic. Emergent attributes may thus be considered creative in that they are novel to the combination. This investigation examined 2 linguistic factors believed to promote such emergence. The relevance and typicality of modifiers were inversely related to the emergence of novel attributes, such that irrelevant and atypical modifications increased emergence. Antonymous and anomalous combinations produced the most emergent attributes. The cognitive mechanisms by which novel attributes emerge, and their relation to creative cognition, are discussed.

Uttering a word is like striking a note on the keyboard of the imagination.

—Wittgenstein (1953, p. 4)

As Wittgenstein (1953) aptly indicated, language is a creative endeavor. The language producer must create coherent combinations of concepts in order to convey a meaningful utterance, and likewise the comprehender must re-create that compound meaning from the meanings of its individual concepts. An important source of creativity in concept combination is *emergence*: Novel features are often attributed to a concept combination that are not attributed to either of its constituent concepts. For instance, a Harvard-educated carpenter is judged to be nonmaterialistic, though nei-

ther Harvard-educated people nor carpenters in general are thought to be nonmaterialistic (Kunda, Miller, & Clare, 1990; see also Hastie, Schroeder, & Weber, 1990). Here the modification of one dimension causes a cascading effect in which other features are subsequently altered, resulting in emergence. Emergent attributes may thus be considered creative in that they are novel to the combination. Several studies have demonstrated this creative emergence of novel features in concept combination (Finke, Ward, & Smith, 1992; Hampton, 1997; Ward, Smith, & Vaid, 1997; Wilkenfeld & Ward, 2001).

More broadly, concept combination has figured prominently in models concerned with several aspects of creative functioning, including idea generation, problem solving, and insight (e.g., Costello & Keane, 2000; Davidson, 1995; Mobley, Doares, & Mumford, 1992; Mumford, Baughman, Maher, Costanza, & Supinski, 1997; Sternberg & Lubart, 1995). A common thread connecting these views is that creative ideas are often the result of attempting to determine how two otherwise separate concepts may be understood together. Indeed, it has often been suggested that concept combination is important to creative advances in a variety of disciplines, including science, art, and business (e.g., Rothenberg, 1979; Thagard, 1984, 1988; Ward, Finke, & Smith, 1995). Given the centrality of concept combination to the creative process, it is important to understand the factors that lead some types of combinations to be more fruitful or emergent

Correspondence and requests for reprints should be sent to Zachary Estes, Department of Psychology, University of Georgia, Athens, GA 30602-3013. E-mail: estes@arches.uga.edu.

than others. This investigation, by using a laboratory procedure in which people were asked to interpret novel combinations of adjectives and nouns, aimed to determine the linguistic factors that promote such emergence.

Two factors believed to facilitate emergence in concept combination are relevance and typicality. Relevance concerns the salience of a dimension in a concept and typicality refers to how characteristic a particular value is on that dimension (Murphy, 1990). For instance, a relevant dimension of the concept shark is its temperament, and a typical feature on that dimension is aggressive, whereas an atypical feature is harmless. An example of an irrelevant dimension of shark is its color, because color is not ordinarily important when considering a shark. The colors gray and black are typical and atypical, respectively, of sharks. The hypothesized roles of relevance and typicality in creative emergence are discussed in turn next.

Relevance is thought to have an inverse relation to emergence. That is, irrelevant concept modification is thought to increase the generation of emergent attributes, because it shifts one's attention from the mundane aspects of a concept to those aspects that do not ordinarily receive consideration. For instance, modification of the less relevant dimension of color for the concept shark, as in the examples gray shark and black shark, might be expected to result in the generation of emergent features. That is, drawing attention to the shark's color might lead one to consider why a shark has the color it does: perhaps gray sharks dwell near the ocean surface, whereas black sharks dwell in deeper waters. In this way, modification of irrelevant dimensions may produce emergent attributes.

The most extreme case of conceptual irrelevance occurs when the modifying concept does not literally apply to the modified noun—that is, anomalous combination (e.g., cloudy enemy). For instance, an enemy cannot literally be cloudy. In such cases, the direct mapping of features may not be plausible. Rather, the combination of unrelated concepts may require a greater level of abstraction, such as metaphor (Estes & Glucksberg, 2000; Mumford et al., 1997), in which the modifier concept is construed to mean something it ordinarily does not mean (Hampton, 1997; Wisniewski, 1996). In support of this hypothesis, Mumford and colleagues (Baughman & Mumford, 1995; Mobley et al., 1992) presented students with two cat-

egories that were either related or unrelated. They then asked the participants to combine the categories and to generate new exemplars of the combined category. The results indicated that the originality of the newly generated exemplars was higher if the to-be-combined categories were unrelated than if the categories were related. Thus, unrelatedness promoted originality in category combination. In another study, Wilkenfeld and Ward (2001) had participants define and list attributes of similar (e.g., guitar–harp) and dissimilar (e.g., motorcycle–carpet) concept combinations. They found that dissimilar combinations produced significantly more emergent attributes. Thus, to the extent that unrelated noun concepts are analogous to unrelated adjective and noun concepts, anomalous modification should lead to the generation of emergent attributes.

Typicality, like relevance, is also thought to have an inverse relation to emergence; as typicality increases, emergence is expected to decrease. This can be explained in terms of Grice's (1975) principles of communication: One assumes that a concept has been modified with another concept for some particular purpose, namely, to emphasize those aspects of the modified concept that differ from the concept when unmodified (Estes & Glucksberg, 1999; Glucksberg & Estes, 2000). In other words, the reason that one specifies harmless shark instead of just shark is to communicate that the shark differs from typical sharks in important respects. In particular, the shark is not aggressive, possibly because it is tame or lacks teeth. In this way, atypical modification may produce emergent attributes.

Hampton (1987) described this presumed effect of typicality in terms of set theory. Of the entire set of sharks, much of that set will overlap with the set of aggressive things, and therefore aggressive sharks will share many of the attributes of sharks. This suggestion formalizes the intuition that when we describe a concept, we describe a typical case of that concept, and thus the attributes of a typical combination (e.g., aggressive shark) will differ little from the attributes of the unmodified concept (e.g., shark). However, the set of sharks will not overlap with the set of harmless things much at all, and hence the attributes of harmless shark may differ markedly from those of sharks in general. Therefore, atypical modification should produce more emergent attributes than typical modification should.

In an early study of creativity and language, Rothenberg (1973) examined the most extreme form of atypicality—that is, antonymy (e.g., sweet sorrow). He proposed that creativity might be linked to what he termed “Janusian thinking,” which he defined as the ability to use two or more opposite or contradictory concepts simultaneously. Rothenberg divided participants into a highly creative group and a less creative group (according to independent criteria) and administered the same word-association experiment to both groups. He found that the highly creative group was more likely than the less creative group to respond with an opposite. Thus, creativity was apparently related to conceptual contradiction, or Janusian thinking. Gibbs and Kearney (1994) more recently demonstrated that antonymous concept modification produced a high proportion of emergent attributes, as suggested by Rothenberg’s (1973) finding.

Research

As described previously, two psycholinguistic factors that may affect the emergence of novel features in concept modification are the relevance and typicality of the modifier to the noun concept. On the basis of the studies outlined earlier, emergence was predicted to increase as relevance and typicality decreased, with the most emergence resulting from extreme irrelevance (i.e., anomalous combinations) and extreme atypicality (i.e., antonymous combinations). We tested these hypotheses in the experiment reported next.

The methodology entailed several stages of data collection. First, in two pretests we verified that the adjectives we used were relevant (or irrelevant) and typical (or atypical) of the nouns they modified (cf. Murphy, 1990). This was done as a validity check: It was necessary to ensure that the adjectives we claimed were relevant were indeed relevant, and that the adjectives we claimed were typical were indeed typical. Sixty experimental stimuli were selected from these pretests. One group of participants then listed features of the individual concepts, and another group listed features of the concept combinations. An emergent attribute was defined as any feature that was listed for the combination but was not listed for either of its constituent concepts (Wilkenfeld & Ward, 2001). For instance, if nonmaterialistic were listed for the combination Harvard-educated carpen-

ter, but were not listed for either Harvard educated or carpenter individually, that feature was emergent. Although several methods of measuring emergence have been used (see Hampton, 1997), this method was chosen because it clearly distinguishes those attributes that are common to the constituent concepts from those that are novel to the concept combination (see Wilkenfeld & Ward, 2001).

Method

Participants

A total of 221 students from an introductory psychology course at Texas A&M University participated in the various stages of experimentation for course credit. No student participated in more than one stage of experimentation.

Materials

Pretests. The purpose of the pretests was to develop a set of stimuli for the concept combination task. Judgments from 8 students were used to verify the experimenters’ intuitions about the perceived typicality of adjectives with respect to their corresponding nouns, and 9 other students provided relevance ratings.

Twelve nouns were used in the typicality rating task. Ten were taken from the direct oxymora contained in Gibbs & Kearney (1994), and two were chosen in accordance with the selection criteria used by those authors for the creation of antonymous combinations (or, in their terms, direct oxymora). The noun constituents of these 12 oxymora were used in the pretest. Each was combined with four adjectives, one each of which was believed to be relevant typical, relevant atypical, irrelevant typical, and irrelevant atypical (cf. Murphy, 1990). None of the adjectives was paired with more than one noun.

Participants rated the typicality of each adjective to its respective noun on a scale ranging from 1 (*very atypical*) to 5 (*very typical*). Two of the atypical combinations were actually rated as somewhat typical by more than 1 participant, so all combinations of these two nouns were subsequently discarded. Excluding these stimuli, the mean ratings of the atypical and

typical combinations were 2.02 ($SD = .57$) and 4.24 ($SD = .78$), respectively. The typical combinations were significantly more typical than the atypical combinations, $t(38) = 10.22, p < .01$.

The relevance rating task consisted of the 10 remaining nouns, with the dimension of modification immediately following. Each noun was therefore listed twice, followed each time by a different dimension. For example, the concept lie preceded both acceptability and, elsewhere in the list, communication because the stimuli to be used in the experiment proper were acceptable lie, unacceptable lie, verbal lie, and nonverbal lie. Item order was random. Mean relevance ratings were 1.66 ($SD = .40$) and 3.50 ($SD = .87$) for predicted relevant and irrelevant dimensions, respectively. The relevant combinations were significantly more relevant than the irrelevant combinations, $t(18) = 6.08, p < .01$. Thus, the stimuli conformed to our experimental requirements and were suitable for use in the experiment proper. See the Appendix for a complete list of the materials.

Procedure of Attribute-Listing Task

An attribute-listing task was used to determine the attributes deemed by participants to be characteristic of each constituent considered in isolation. Two lists were constructed, and each list consisted of 35 individual concepts (5 nouns and 30 adjectives). Each list was completed by 27 students (54 participants total). Order of concepts was random within list, subject to the constraint that the 5 nouns were presented before the 30 adjectives. No concept appeared more than once either within or across lists. Forty of the 60 adjectives and all 10 nouns were those selected from the pretest. Ten of the adjectives were antonymous to the nouns (primarily from Gibbs & Kearney, 1994). The final 10 adjectives were selected to create the anomalous combinations (cf. Murphy, 1990). The attribute lists provided a bank of features against which to check for emergent attributes from the concept combination task (Hampton, 1987; Wilkenfeld & Ward, 2001).

Procedure of Concept-Combination Task

Six experimental lists were constructed, with combination type manipulated between subjects. Thus,

each list consisted of 10 combinations. Each of the six lists was completed by 25 participants (150 participants total). Participants were instructed to “think of a single meaning that best describes the pair.” After all 10 definitions had been completed, participants were asked to “list all of the attributes that something would need to be considered a good example of the definition.” Participants then reread their definition for each combination and listed attributes of the combination below its definition. The purpose of this second phase was to clarify the meanings of the definitions and allow elaboration (Wilkenfeld & Ward, 2001).

Scoring

Every attribute for each concept combination was checked against the attribute lists for its two constituents by the following method. For each constituent, a database of every attribute listed by any participant in the attribute listing task for that concept was generated. Thus, each concept had a bank of features. Next, every feature listed for each combination was checked against the two attribute lists of the constituents of the given combination. A feature was scored as emergent only if it or any synonym of it was not included in either of the lists for the constituents. We thus operationally defined an emergent attribute as any attribute that was produced for the combination but not produced for either constituent alone (see Hampton, 1997, for other methods). Also, only one synonym was tallied for the count of emergent or total attributes. That is, angry and mad were not treated as two separate attributes; rather, they were counted only once as angry/mad. Note that every feature listed for a concept, even if listed by only 1 participant, was included in that concept’s feature bank. Therefore, this procedure is somewhat conservative in its measurement of emergence.

Results

One participant did not follow instructions and was therefore excluded from analyses. Analyses of emergence were based on proportions of total attributes that were emergent (i.e., the sum of emergent attributes divided by the sum of total attributes). Across all six experimental conditions, one third of the attributes

were found to be emergent. A significant difference in emergence among conditions was revealed by a one-way analysis of variance (ANOVA), $F(5, 143) = 10.28$, $p < .001$, indicating that the experimental manipulation produced a significant effect on the emergence of novel features. The proportions of emergent attributes were as follows: relevant typical = .22 ($SD = .14$), relevant atypical = .31 ($SD = .13$), antonymous = .37 ($SD = .08$), irrelevant typical = .25 ($SD = .13$), irrelevant atypical = .37 ($SD = .19$), and anomalous = .45 ($SD = .09$). To test for the predicted effects of relevance and typicality on emergence, a two-way (Relevance \times Typicality) ANOVA was conducted on the relevant typical, relevant atypical, irrelevant typical and irrelevant atypical conditions. There was a significant main effect of typicality on emergence, $F(1, 95) = 12.41$, $p < .01$, but no reliable effect of relevance on emergence, $F(1, 95) = 1.97$, $p = .16$. The interaction was not significant.

To summarize, then, atypicality increased emergence as predicted, whereas irrelevance had no reliable effect. However, the anomalous combinations, which are the most extreme case of irrelevance, produced the most emergence. Thus, irrelevance did have an effect on emergence, though extreme irrelevance was necessary to observe the effect.

Discussion

An interesting and systematic pattern of results obtained. First, typicality clearly influenced the emergence of novel attributes in concept modification: Emergence was a decreasing function of typicality. This is consistent with a Gricean interpretation of the data, in which one assumes that a concept has been modified to emphasize the ways in which the modified concept differs from the concept when it is not modified in this way. It is important that emergent attributes distinguish the modified concept from the unmodified concept (Estes & Glucksberg, 1999; Glucksberg & Estes, 2000). And consequently, emergent attributes were emphasized by atypical modification. At the end of the typicality spectrum lie antonymous combinations, such as friendly enemy. These combinations produced an even higher proportion of emergent attributes (.37), thereby corroborating Rothenberg's (1973) Janusian hypothesis that conceptual contradiction facilitates creativity.

The influence of irrelevance on the creative emergence of novel attributes was equivocal. On the one hand, the main effect of relevance was nonsignificant. But on the other hand, when the anomalous combinations were included in the analysis, they were shown to produce the most emergence of all experimental conditions. In this respect, irrelevance does have an effect, but the degree of irrelevance must be substantial. This result supports the claim that unrelatedness fosters creativity (Baughman & Mumford, 1995; Mobley et al., 1992; Wilkenfeld & Ward, 2001).

Cognitive Mechanisms by Which Novel Attributes Emerge

In this investigation we have determined two linguistic factors that affected the emergence of novel attributes in concept modification. However, a more fundamental question has not been addressed: What are the cognitive mechanisms by which novel attributes emerge? There are at least three processes by which emergent attributes may arise. First, emergence may result from extensional feedback (Gray & Smith, 1995; Hampton, 1988, 1997; Medin & Shoben, 1988; Murphy, 1988; Rips, 1995). Extensional feedback is the retrieval of information from a remembered instance of the combined concept (or in other words, from a member of the extension of the combined concept). For instance, the combination pet bird is familiar, and so we may retrieve emergent attributes from what we already know about pet birds. Pet birds may talk, though neither pets nor birds typically talk (Hampton, 1988). The emergent attribute *can talk* arises from prior knowledge of the combined concept.

Another source of emergence is inferential reasoning. This entails reasoning about or inferring what the features of the combined concept are likely to be. For example, if one interprets the presumably unfamiliar combination squirrel box to mean a box for keeping squirrels in, he or she might reason that the squirrel box probably has airholes in it so the squirrel can breathe. In inferential reasoning such as this, general knowledge is consulted to infer or create features of the combined concept.

Finally, emergence may result from an increase in the salience of an extant attribute, where the emergent attribute is present but not salient in one or both of the constituent concepts. The previously nonsalient

feature then becomes salient as a result of the modification. For example, sharks ordinarily dwell near the ocean surface, but this feature may not be salient until the concept is modified, as in gray shark. Here the attribute is true of sharks in general, but becomes salient only as a result of the modification (i.e., being gray favors surface habitation). By this process, concept modification emphasizes some aspect of a concept that ordinarily is not emphasized.

Of these three potential causes of emergence, only two are germane to creativity. Extensional feedback may not be considered creative because it strictly uses retrieval from extant knowledge (Hampton, 1997). Inferential reasoning also involves the retrieval and application of extant knowledge, but differs in that it is an inference toward the creation of a novel attribute rather than simple retrieval of an attribute. Emergence as a result of an increase in the salience of an extant attribute may also be considered creative in that extant knowledge is reorganized in potentially productive and creative ways (Baughman & Mumford, 1995; Finke et al., 1992; Mumford et al., 1997). Thus, inferential reasoning and increased salience may be considered creative forms of emergence, though extensional feedback may not.

Concerning this research, the irrelevant and atypical combinations likely produced creative emergent attributes, because their unfamiliarity presumably disallowed extensional feedback. But the relevant and typical combinations, because of their inherent familiarity, were more amenable to extensional feedback, and therefore were unlikely to use creative cognitive processes.

Models of Emergence in Concept Combination

Models of concept combination differ in their success at accounting for the creative emergence of novel attributes. The selective modification model of concept combination (Smith, Osherson, Rips, & Keane, 1988), which was explicitly intended to explain unidimensional modification, cannot account for emergence. According to this model, when an adjective modifies a noun, the adjective selects the appropriate dimension in the noun representation and modifies that dimension with the value specified by the adjective.

For instance, in comprehending red apple the modifier red simply fills the color dimension of the noun concept apple. Because this model posits a strict and straightforward process of modification, it unfortunately cannot account for emergent attributes. If brown apple were simply comprehended by mapping brown into the color dimension of apple, where would the emergent attribute *mushy* come from?

One way to account for emergent attributes was proposed by Murphy (1988). Murphy posited a two-stage model of concept combination in which a combinatorial process similar to that of the selective modification model may be followed by an elaborative process. That is, after combining the concepts and comprehending the immediate modification (e.g., that a brown apple should be an apple having its color dimension filled with the value brown), the combination might be elaborated on by the addition or removal of peripheral features. For instance, the feature *mushy* might be added to the combination, and the feature *sweet* would likely be removed from the meaning of the combination brown apple. Thus, novel attributes are said to emerge as a result of conceptual elaboration. Several other models also allow such postcombination addition and deletion of features (e.g., Baughman & Mumford, 1995; Hampton, 1988; Wisniewski, 1997).

This idea of accounting for the emergence of novel attributes in terms of elaboration fits neatly within the Genevieve framework of creative cognition (Finke et al., 1992; Smith et al., 1988; Ward et al., 1995). According to the model, creative cognition results from “an interplay between *generative* processes that produce candidate ideas of varying degrees of creative potential and *exploratory* processes that expand on that potential” (Ward, 2001). Generative processes include the retrieval of concepts and images, as well as the association and combination of those concepts and images. Exploratory processes include the modification, elaboration, and transformation of the generated concepts and combinations (Ward, 2001). Thus, according to Genevieve, the combination of concepts leads not only to the generation of a basic interpretation of the combination, but also to the elaboration of that interpretation, potentially producing emergent attributes. These basic processes of generation and exploration clearly underlie many other creative cognitions such as problem solving and analogy as well.

To conclude, then, we have developed the following picture of the creative emergence of novel attributes: The emergence of attributes in concept combination appears to result from either extensional feedback, inferential reasoning, or an increase in salience, all of which likely occur during an elaboration process after the combination process. This investigation demonstrated that irrelevance and atypicality promoted this emergence of attributes that are salient in a concept combination but are not salient in either of its constituent concepts.

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Appendix: Stimuli Used in Concept-Combination Task

Nouns	Adjectives					
	Relevant			Irrelevant		
	Typical	Atypical	Antonymous	Typical	Atypical	Anomalous
Enemy	Hostile	Indifferent	Friendly	Dressed	Undressed	Cloudy
Illness	Harmful	Harmless	Healthy	Feared	Desired	Hinged
Joy	Cheerful	Unemotional	Painful	Spontaneous	Deliberate	Grassy
Lie	Unacceptable	Acceptable	Truthful	Verbal	Nonverbal	Crusty
Shade	Cool	Warm	Sunny	Visible	Invisible	Liquid
Sky	Blue	Purple	Grounded	Permanent	Temporary	Heroic
Marriage	Satisfying	Depressing	Divorced	Christian	Pagan	Thick
Delay	Long	Scheduled	Speedy	Boring	Entertaining	Soupy
Simplicity	Clear	Unclear	Complex	Logical	Illogical	Zipped
Death	Tragic	Celebrated	Living	Urban	Rural	Round