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Similarity and Emergence in Conceptual Combination

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The influence of similarity on emergence in interpretations of conceptual combinations was assessed. Participants wrote two definitions for each of eight similar and eight dissimilar word pairs and then listed the important features of each definition. Those features were compared with the features collected from a different group of participants who listed the characteristic properties of the parent concepts presented individually. Features listed for the combinations but not for the parent concepts separately were considered emergent. Similar pairs led to fewer emergent features than dissimilar pairs, and first attempts at defining the combinations produced fewer emergent features than second attempts. Definitions of similar pairs more often assigned a property of one concept to the other, whereas definitions of dissimilar pairs more often identified a thematic relation between the concepts. Similar pairs and first attempts also had higher proportions of features from within the structural alignments of the combinations' parent concepts. The results are consistent with the influence of structural alignment on conceptual combination and with a "quick fix" hypothesis. Members of similar pairs, which could easily be aligned, facilitated the identification of a property of the modifier to project onto the head noun, and their compatible structures required little emergent modification to incorporate the projected property. Dissimilar pairs, whose structures were less readily alignable, provided fewer projectible properties, required more emergent modification to incorporate them, and more often required participants to go beyond the alignable properties of the parent concepts to achieve coherent interpretations. On second definitions, participants may have pursued less satisfactory secondary alignments that led to less property projection more emergent features.

Key Words: conceptual combination; emergent properties; categories; concepts.

A striking characteristic of human cognition is our capacity to produce and comprehend conceptual combinations that merge previously separate concepts into units that express new thoughts and stimulate new ideas. Because combinations can describe things that were previously unlabeled, such as "homepage," "soccer mom," and "couch potato," they can serve to expand the language and have even been linked to creative productivity (Donaldson, 1991; Mobley, Doares, & Mumford, 1992; Mumford, Baughman, Maher, Costanza, & Supinski, 1997; Rothenberg, 1979).

A particularly intriguing aspect of conceptual combinations is that they can yield emergent properties, that is, properties that people identify as being characteristic of a combination but not of either of its constituents (see, e.g., Hampton, 1987, 1997; Hastie, Schroeder, & Weber, 1990; Kunda, Miller, & Claire, 1990; Murphy, 1988). For instance, "homepages" are now commonly understood to be personal electronic entries on the World Wide Web, properties that people would be unlikely to list as being characteristic of either "homes" or "pages" considered separately. Such emergent properties can be truly novel in the sense that they appear in the combination without being present at all in the representation of either parent concept, or they can merely be newly salient in the sense that they are in the representation of one or both parent concepts but low enough in importance that people would not think to list them when considering the parents in isolation. Either type of emergence, however, reflects a change in the way the concepts are interpreted; even in the newly salient case, an attribute that was unimportant enough to come to mind for either constituent in isolation becomes prominent in the combination. Determining the factors that underlie such changes is essential to a complete understanding of how people interpret combined concepts.

A second and potentially related aspect of conceptual combination is that the same com-

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bination can yield multiple forms of interpretation, including *relation linking*, in which the constituent concepts play complementary roles in some thematic relation; *property interpretation*, in which a property is projected from one concept to the other; and *hybridization*, in which the combination is seen as a cross or blend between the constituents (see, e.g., Wisniewski, 1997b). For instance, a combination such as “zebra horse” could yield the relational interpretation of “a horse for herding zebras,” the property interpretation of “a striped horse,” or the hybrid interpretation of “an animal that is a cross between a zebra and a horse.”

The present research focused on both of these aspects of conceptual combination and more specifically on how the degree of similarity between the parent concepts of a combination can influence both the form of the interpretation and the amount of emergence that occurs. It also focused on the extent to which similarity-based effects on interpretations and emergence are either interrelated or distinct from one another.

Our focus on similarity stemmed initially from anecdotal reports as well as experimental findings and theoretical proposals that lead to the expectation that emergence will be inversely related to the similarity of a combination’s constituents. Anecdotally, creative people from many different disciplines report that they use combinations as a source of creative ideas and that conceptual combination is particularly inspiring when the components of the combination are *dissimilar* (Donaldson, 1991; Rothenberg, 1979). The implication is that the more divergent the component concepts are, the more emergently creative the outcome will be.

Consistent with these anecdotal reports, there is suggestive experimental evidence for a link between similarity and emergence, particularly from studies using intersective or conjunctive combinations, in which an entity is specified as being simultaneously a member of two constituent categories. For instance, Kunda et al. (1990) had participants describe either a target person who is a member of a “surprising” conjunction of social categories (e.g., a person who is Harvard-educated and a carpenter) or a person who is a member of one or the other of the constituent categories (e.g., a person who is Harvard-educated or a person who is a carpenter). They found evidence for emergent properties in that the descriptions of the conjunctions contained properties that were not listed for either of the constituent categories (e.g., Harvard-educated carpenters were sometimes described as nonmaterialistic, whereas Harvard educated persons or carpenters alone were not). Using similar procedures, Hastie et al. (1990) found more emergent properties for incongruent than for congruent conjunctions (e.g., Republican social worker versus Republican bank teller), and Hampton (1997) reported a great deal of emergence for imaginary conjunctions with no overlapping members (e.g., furniture which is also fruit). Although surprisingness, congruence, and set overlap are not necessarily direct indicators of the similarity of a conjunction’s constituents, it is reasonable to suppose that less surprising, more congruent, and more overlapping constituents are more similar to one another than are surprising, incongruent and nonoverlapping constituents. Consequently, the results provide at least suggestive support for an inverse relation between similarity and emergence.

Building on these earlier findings, the present studies used a more direct measure of concept similarity (i.e., participants’ ratings) and assessed the degree to which interpretations of similar and dissimilar noun–noun combinations yield emergent properties. They also extended the earlier findings to nonpredicating combinations that can take many forms of interpretation other than joint membership in their constituent categories. That is, we used combinations, such as “helicopter blanket,” which would be unlikely to be interpreted as the class of things that are “helicopters and also blankets” but which could reasonably be interpreted in a variety of other ways. Because these types combinations are especially common, it is essential to understand how they are interpreted and how the similarity of their constituents affects their interpretation. In addition, by examining such combinations it is possible to determine the extent to which the form of interpretation (e.g., relation linking versus property interpretation) and the amount of emergence are interrelated.

The present work also stemmed from a combination (no pun intended) of theoretical perspectives on conceptual combination. To account for the presence of emergent properties, Kunda et al. (1990) proposed that the surprisingness of a social conjunction prods people to engage in causal reasoning to explain how a target person might be a member of two incongruent social categories. In a related vein, other investigators have suggested that people might develop mental simulations or engage in other forms of reasoning to resolve apparent conflicts that arise from considering simultaneous membership in otherwise discrepant categories (e.g., Hampton, 1997; Hastie et al., 1990; Thagard, 1984).

These various types of reasoning mechanisms are particularly applicable to conjunctive categories for which simultaneous membership in incongruent categories would force people to try to resolve conflicts between potentially incompatible properties of those categories. However, we suspect that the mechanisms also apply more generally to other forms of conceptual combination. Consequently, we anticipate that, even for noun–noun combinations in which the entity need not be simultaneously a member of two contrasting categories, the degree of similarity between the constituent categories will still influence the number of emergent properties observed.

It is important to note, however, that although conflict resolution processes may come into play when people interpret combinations, those reasoning processes alone cannot provide a complete account of the interpretation process. For example, although surprisingness clearly provokes causal reasoning, there must be some means by which the surprisingness of a conjunction is initially determined. In addition, for combinations for which the entity is not specified as a member of both constituent categories, there must be some process by which a person develops a reasonable idea of the nature of the link between the constituents to begin with. At a minimum, there must be processes that can lead to interpretations in the form of relation linking, property projection, and hybridization.

Although a number of models can explain how people might arrive at relation linking interpretations (Cohen & Murphy, 1984; Murphy, 1988; Shoben & Gagne, 1997), and others provide an account of conjunctive interpretations (e.g., Hampton, 1987), most do not predict the full range of interpretation types. In contrast, Wisniewski's (1997a, 1997b) dual-process model posits two distinct mechanisms in an attempt to account for all three types of interpretation, and it also has implications for how similarity will influence interpretations.

To account for property and hybrid interpretations, Wisniewski proposed a comparison and construction process that uses the principles of structural alignment (see, e.g., Markman & Gentner, 1993) to align the representations of the constituents, identify their commonalities and differences, determine which properties of the modifier should be projected onto the head noun, and instantiate some new version of the selected properties in the head noun. The comparison process competes with a scenario creation process, which seeks to identify different but complementary roles for the modifier and head noun in a thematic relation. The processes are assumed to run in parallel, with the comparison and construction process potentially culminating in property interpretations or hybridizations and the scenario creation process potentially culminating in relation linking interpretations. Which process "wins," and hence, which type of interpretation is expressed for a given combination is assumed to be influenced by the similarity of the component concepts.

The dual-process model correctly predicts the fact that combinations of parent concepts that are similar to one another lead to more property interpretations, whereas dissimilar pairings lead to more relation linking (Wisniewski, 1996, 1997a, 1997b). Because similar concepts share many commonalities and alignable differences (i.e., differences that exist along some common underlying dimension), projecting properties from one concept onto the other is straightforward. For example, a comparison of the similar concepts "guitar" and "harp" could readily identify an alignable difference in the number of strings and lead to the property interpretation, "a six-stringed harp." In addition, similar entities would tend to have the capacity to fill *similar* roles, which could make it difficult to construct a relational scenario in which they would play *different* roles. In contrast, the limited alignability of the attributes of dissimilar concepts (e.g., "couch" and "skate") makes it difficult to find properties of one that could reasonably be projected onto the other to form a property interpretation. A scenario construction process, however, might readily identify complementary roles for the differing objects, leading to a relation linking interpretation (e.g., "a runnerlike object for moving a couch"). High similarity does not rule out relation linking (e.g., "zebra horses" that "herd zebras"), nor does low similarity preclude property interpretations (e.g., "a large skate that seats three"), but variations in alignability and role-filling capacity would increase the likelihood of property interpretations for similar pairs and relation linking interpretations for dissimilar pairs.

Given the possibility that similarity might influence both the extent of emergence and the form of the interpretation, it is essential to carefully assess the degree to which those effects are interrelated or separate. Our view is that, even though low similarity may increase both the likelihood of emergence and the probability of giving a relation linking definition, there is no direct connection between the amount of emergence and the form of the given interpretation. Relation linking does not foster emergent properties any or more or less so than property interpretation. Rather, either type of interpretation may or may not contain emergent properties.

To see how emergence can occur for all types of interpretations, and to set the stage for considering the complexity of the linkages between similarity, interpretation type, and emergence, it is important to note that people's understandings of combined concepts are richer than the shorthand labels that refer to the projected properties or relations. This is due, in part, to the fact that projecting a property or relation is best viewed as a constructive process of integrating knowledge into the head noun of a combination rather than as simply a matter of placing an exact copy of a known property or relation into its representation (see, e.g., Wisniewski, 1996, 2000). The process of constructing the interpretation may entail modifications to the property or relation being projected or to the head noun receiving it, either of which could result in emergence. In addition, properties contained in a concept's representation are not independent of one another, so that a change in one property (as indicated by a property interpretation) might imply potentially emergent changes in others (see, e.g., Medin & Shoben, 1988). For instance, a "guitar harp," defined via the property interpretation of "a six-stringed harp," may differ from ordinary harps in several ways that are connected to its having six strings (e.g., size, shape, manner of play, and type of music played), and the strings may well be expected to differ from ordinary guitar strings in ways that make them more appropriate for the structure of a harp (e.g., larger, thicker, and made of a different material). Similarly, for a pair such as "helicopter blanket," the relation linking definition of "a blanket to cover a helicopter" would almost certainly not simply refer to an ordinary blanket thrown over an ordinary helicopter. Rather, for a helicopter blanket to adequately serve the role of a protective cover, it would have to differ from ordinary blankets in several ways, including size and material composition. Consequently a person might need to modify the representation of "blanket" to allow it to play such a role, and the modifications could take the form of emergent properties.

Because judged similarity is an indicator of how alignable concepts are, to the extent interpretations are driven by an alignment process, comprehending similar pairs should result in less emergence than comprehending dissimilar pairs. When interpreting a similar combination, the existence of readily alignable structures would not only facilitate the identification of an alignable difference and the projection of the associated value from the modifier to the head noun, the absence of major conflicts across the aligned structures would allow a "quick fix." That is, there would be little pressure to modify either of the constituents or to import properties from outside the alignment to achieve a satisfactory definition. For example, a comparison process would not identify many strongly incongruent or conflicting properties of zebras and horses, so that "a striped horse" could provided a satisfactory definition of "zebra horse" without requiring the person interpreting the combination to make major modifications to their representations of "horse" or the zebra's stripes. There would be little need for the reasoning processes described earlier to resolve conflicts and, consequently, few emergent properties would be expected. As with the link between similarity and interpretation type, this is a relative, not absolute argument. High similarity would not preclude emergent properties, but would be expected to reduce their likelihood of occurrence.

In contrast, dissimilar pairs, whose discrepant structures do not readily align, do not allow a quick fix or easy integration of the properties of one concept into the other. Thus, attempting to define a dissimilar combination would tend more often to push the processor beyond the characteristic attributes of the component concepts to resolve conflicts or explain how the concepts might be integrated. For example, if an alignment process yielded a property interpretation for a dissimilar pair (e.g., "a large skate that seats three" for the combination "couch skate"), that process would also presumably reveal discrepancies between the structures of the component concepts. Consequently, the projected property would tend to require more modification to integrate it into the head noun than in the case of a similar pair, a point that Wisniewski (1998) has recently demonstrated. In addition, the dependent nature of concepts' properties implies that there would need to be greater modification of the head noun as well. The representation of skate, for instance, would need to be drastically altered (e.g., eliminating properties such as "laces" and "worn on feet"), and the modifications would likely contain emergent properties, such as "motorized" (to explain how a three-seater couch skate might move) or "seat belts" (to hold the seated skaters in place).

Because property interpretations are assumed to result from an alignment process, and because the similarity between concepts is generally thought to be indicative of the alignability of their properties, the predictions regarding a link between similarity and emergence are clearest for property interpretations. The case for a connection between similarity and emergence in relation linking definitions is less clear because they are assumed to result from a scenario creation process rather than from an alignment-based comparison process. Emergence for relation linking definitions might be influenced by the ease with which the component concepts could play complementary roles in a scenario, but similarity has not generally been viewed as indicative of that ease.

An important reason for entertaining the possibility of a link between similarity and emergence even for relation linking interpretations, however, is that the dual-process model assumes that the comparison and scenario processes run in parallel. Thus, it is conceivable that emergent properties that are activated while attempting a plausible interpretation via comparison could make their way into the final interpretation even if it took the form of a scenario-based relation linking definition. Put differently, the processes need not be viewed as entirely insular. Indeed, conflicts identified in the alignment and comparison of the modifier and head noun could well serve as guides to the types of emergent modifications that would be needed to allow the head noun to play its role in the relation. For example, a discrepancy in size could prompt the idea that a helicopter blanket would need to be very large (with respect to typical blankets), and a discrepancy in material type (sharp metal versus soft fabric) could suggest that a protective helicopter blanket would need to be made of a stronger material than is typical for blankets (e.g., canvas).

A final issue to be examined is the extent to which emergence changes as people are asked to generate second definitions for the same pairs. If emergence is inversely related to the ease of alignment, then, all other things being equal, there should be more emergent properties observed in later attempts at defining combinations. This is because the easiest alignment would be expected to be used first, leading to a subsequent reliance on secondary, less satisfactory alignments. Whether the shift should be stronger for similar or dissimilar pairs is uncertain. Because an initial quick fix is more readily available for similar than for dissimilar pairs, the requirement for a second definition might produce a greater shift toward emergence for similar pairs, as that initial alignment advantage is used up on the first definition. Alternatively, it is possible that similar concepts have many easily alignable differences, such that other quick fixes are available for subsequent definitions.

To summarize, the present studies test the main predictions of the "quick fix" hypothesis that combinations of dissimilar concepts will yield more emergent features than combinations of similar concepts and that second definitions will yield more emergent features than first definitions. An additional goal of this research was to differentiate between the methods of combination used (e.g., property interpretation versus relation linking) and the likelihood of emergence occurring.

To test these predictions a multiphase experiment was conducted. In the first phase, pairs of similar and dissimilar concepts were identified. In the second phase, participants listed attributes of the parent concepts of those combinations to provide a feature base of attributes that characterize each concept in isolation. In the third phase, a different group of participants defined the combinations and listed their attributes. Attributes present in the third but not the second phase were considered to be emergent. Participants in the third phase gave two definitions of each combination so that we could assess changes in emergence with multiple attempts at interpretation. The final phase had participants list commonalities and differences for the pairs of parent concepts so that interpretations from the third phase could be characterized in terms of the extent to which they made use of commonalities, alignable differences, nonalignable differences and extraalignment features.

PHASE ONE: SELECTING SIMILAR AND DISSIMILAR STIMULI

This phase of the study was designed to identify similar and dissimilar pairs of concepts by having participants rate the similarity of a large set pairs selected from the domain of "nonliving things." The pairs receiving the highest and lowest ratings were selected for use in later phases.

Method

Participants. The participants were 53 Texas A&M undergraduates from the psychology participant pool. In return for their participation, students received course credit in an introductory psychology class.

Stimuli. A list of 90 word pairs was formed by selecting items from the following categories: tools, musical instruments, wheeled vehicles, nonwheeled vehicles, natural items, manufactured items, containers, and furniture. The list of pairs contained 45 pairs that were assumed to be similar and 45 pairs that were assumed to be dissimilar. Each individual word was used at least twice, once in a similar pair and once in a dissimilar pair. These pairs were organized on a list by randomly interspersing similar and dissimilar pairs. The final list of 90 pairs was then presented in two orders, one the reverse of the other, to control for order effects.

Procedure. Participants were asked to rate the similarity of each pair using a Likert-type scale, which was next to each pair. Scale values ranged from 1 to 7, with 1 indicating that the items were completely similar and 7 indicating that they were completely different.

Results

Participants' ratings were used to select the eight most similar pairs and eight most dissimilar pairs. The similar pairs, which each had mean ratings *lower* than 3.2 were *saw scissors*, *drill hammer*, *train trolley*, *sled ski*, *pool puddle*, *cup bowl*, *guitar harp*, and *dirt mud*. The dissimilar pairs, which all had mean ratings higher than 6.7, were *oil bag*, *couch skate*, *airplane puddle*, *helicopter blanket*, *computer ski*, *car milk*, *motorcycle carpet*, and *pudding metal*.[1]

[1] There was one other pair that had a rating higher than 6.7 which was not included. This pair was *snowmobile bass* and was eliminated because it was apparent that the participants had considered "*bass*" to be a fish (a living creature) rather than a musical instrument, as was intended.

PHASE TWO: FEATURE DATABASE FOR INDIVIDUAL CONCEPTS

In this phase, a feature listing task was used to obtain a database of features associated with the individual constituent concepts of the 16 combinations chosen in Phase One. The database was generated to allow an assessment of emergence in a subsequent combination task (Phase Three). Features found to be associated with a given combination in Phase Three were considered to be emergent only if they did not appear in the database of features for either of its constituent concepts.

Method

Participants. The participants were 63 Texas A&M undergraduates from the psychology participant pool. In return for their participation, students received course credit in an introductory psychology class.

Stimuli. The 16 pairs of words that were selected in phase one were separated into a randomly ordered list of 30 single words (two words were in two combinations each, therefore, there were only 30 unique words to test). Each word was presented on a page with three other words to allow for enough room to write at least six features for each word.

Procedure. The participants were told that we were interested in what features make up their definitions of various words and that they should write down at least six features that describe each word that they were about to see. They were further instructed to avoid purely personal or idiosyncratic free associations to the words. Participants were given 50 min to write features for all 30 words.

Results

Each feature was entered into a database under the word that it defined. Features were collated within the database to ensure that synonyms were noted, but even features that were only listed by one participant were included. This procedure of including even those features mentioned by only one person was intended to provide a list of features of the parent concepts that was as comprehensive as possible. The resulting database of more than 11,000 features was then referred to when making judgments about emergence.

PHASE THREE: CONCEPTUAL COMBINATION AND EMERGENCE

In this task, participants interpreted all 16 combinations. They gave two definitions for each pair, and after completing all of the pairs, wrote feature lists for each definition. The responses were used to determine if there was a difference in number of emergent features depending on whether the parent concepts were similar or dissimilar and to assess whether any such observed difference persisted across multiple attempts at interpreting the combinations.

We operationally defined emergence as the listing of an attribute for a combination but not for either of its parent concepts alone, which allowed us to capture changes in the interpretation of the concepts, whether they reflect the generation of truly novel properties or merely an increase in the salience of the properties. Specifically, we considered features listed for the combinations to be emergent only if they were not in the database of features listed for each of the parent concepts.

This method of determining emergence differs from that used by Hampton (1987), who considered features to be emergent if they were judged by participants to be true of the combination but not of the parent concepts alone (see also Hampton, 1997). This type of emergence judgment is particularly appropriate for reasonably familiar combinations (e.g., birds that are also pets), where most participants would define the combinations in the same way and there would be consensus about the likely features of the combination. If everyone interprets “pet bird” to refer to a real bird that would also be a pet in the ordinary sense, then it is reasonable to ask whether the majority judge “living in a cage” to be true of “pet birds.” If the majority does so, but only a minority judge “living in cage” to be true of “pets” or “birds” in isolation, then the shift in ratings can be taken as an indicator of emergence.

In the present study, however, our combinations were unfamiliar and novel. We expected that our participants would develop many unique definitions for the pairs of words and that their features would make sense primarily in the context of those definitions. For example, if only one person defined motorcycle carpet as “a field of thousands of motorcycles,” that person might go on to list the emergent property of “crowded” for the combined concept. Without providing the context of such a definition, it is unlikely that most raters would agree that “crowded” is true of “motorcycle carpet” because they would be judging the feature in relation to their own idiosyncratic interpretation of the meaning of “motorcycle carpet.” Thus, a feature that really did emerge from the individual’s processing of the combination would not be counted as emergent simply because other raters would have their own distinct definitions of the combination.

It would be impractical to have raters judge each listed feature in the context of each listed definition (e.g., to judge whether “crowded” is true of motorcycle carpet when it is defined as “a field of thousands of motorcycles” and to judge whether “greasy” is true of motorcycle carpet when it is defined as “a mat to put under a motorcycle when you work on it,” and so on). And although it would have been feasible to obtain judgments about the features with respect to the component concepts in isolation, without corresponding judgments for the combinations we would not have been able to assess whether the features were seen as being *more true* of the combination than of either of its constituents. Because of this important difference, we did not use the “judgment” definition of emergence. We were concerned that many emergent properties would be lost simply because they were not understood by the majority of participants. In addition, the listing and rating procedures have been found to yield comparable results (e.g., Hastie et al., 1990; Kunda et al., 1990), so it is unlikely that our pattern of results is driven solely by our use of the listing measure.

Method

Participants. The participants were 65 Texas A&M undergraduates from the psychology participant pool. In return for their participation, students were given course credit in an introductory psychology class. One participant failed to complete all definitions and was excluded from all analyses.

Stimuli. The stimuli were 16 word pairs, the 8 highly similar and 8 highly dissimilar pairs that were chosen in Phase One. The pairs were presented in two different orders generated at random. Each pair was presented with two lines below it labeled “def:” with spaces between the two lines. There were 4 pairs per page to allow room for writing feature lists.

Procedure. The participants were told that we were interested in how people define new phrases. They were asked to think of and write down two different definitions for each of the 16 pairs and were given 16 min to complete the task.

Once the first part of the task was completed, the participants were asked to further describe what each of their definitions meant. They were instructed to list features that something would need to be considered a good example of each definition they wrote. Participants were told to write those features directly beneath each definition that they wrote and to come up with a different set of features for each definition. Participants were given 35 min to complete this task.

Results

Several dependent variables were examined: the number of emergent features per pair, total number of features for each pair, and method of combination for each definition. Each dependent variable was calculated separately for each of the two attempts at defining each combination. In addition, preliminary analyses included an evaluation of the effect of test form (each of the two random orders) on each of the variables. As the two test forms yielded no significant main effects or interactions, the data were collapsed across test form for all subsequent analyses.

Number of emergent features. To determine the number of emergent features, the databases of features from the feature listing task were compared to the definitions and feature lists from the conceptual combination task. If features listed for a combination (from this phase) were not listed for either of the parent concepts (from Phase Two), those features were considered emergent.

During this comparison process, we looked for synonymy of features. This meant that a feature from the combination would be considered emergent only if it and its synonyms did not appear in the parent concept feature lists. For example, one of the features listed for *metal* was "malleable." Thus, when the combination *pudding metal* was interpreted, the feature "bendable" would *not* be considered emergent because its synonym "malleable" had been listed in the parent concept database even though "bendable" itself had not been listed as a feature of the parent concepts. This procedure makes the estimate of emergence more conservative.

For each participant we derived four separate emergence scores by averaging across their responses to each of the eight individual similar pairs and each of the eight individual dissimilar pairs separately for each of the two definition attempts on each pair. Means of these emergence scores are shown in Table 1. Emergence scores were analyzed using a repeated-measures analysis of variance (ANOVA). The effect of pair similarity was significant [$F(1, 63) = 18.22$, $p < .001$]. As predicted, there were more emergent features for dissimilar pairs than similar pairs. The effect of order of attempt at defining (first definition vs second definition) was also significant [$F(1, 63) = 15.47$, $p < .001$]. This result followed the predictions as well; participants produced more emergent features in their second attempt at defining a pair than they did in their first. Last, the similarity by order of attempt interaction was marginally significant [$F(1, 63) = 3.55$, $p < .064$]. Four pairwise *t* tests were done as post hoc means comparisons, and the experimentwise error rate was held to .025. The increase in emergent features from the first to the second attempt at providing a definition was significant for the similar pairs [$t(63) = -4.37$, $p < .001$], but not the dissimilar pairs. Additionally, the dissimilar pairs led to more emergence than the similar pairs only on the first attempts at defining pairs [$t(63) = 4.48$, $p < .001$], not second attempts.

In addition to the preceding analysis, the means were collapsed across subjects, and an item analysis was performed. Because similar and dissimilar pairs are different items, this required that similarity be treated as a between-subjects factor and order of attempt at defining was treated as a within-subjects factor. The item ANOVA revealed significant effects for similarity [$F(1, 14) = 9.47$, $p < .008$] and order of attempt at defining [$F(1, 14) = 9.15$, $p < .009$], but their interaction was not significant. Thus, the item analysis confirmed the main findings obtained from the subject analysis with the exception of the marginal interaction between similarity and definition attempt. The absence of a significant interaction in the item analysis requires that the apparently greater shift toward emergence for second definitions of similar pairs be viewed with caution.

TABLE 1

Mean Number (and Standard Deviation) of Features Produced by Participants

Type of pairs	First definition	Second definition
Emergent features		
Similar	1.31 (.77)	1.67 (.88)
Different	1.73 (.66)	1.87 (.75)
Total number of features		
Similar	6.36 (1.14)	6.16 (1.20)
Different	6.26 (1.14)	6.22 (1.30)

Total number of features. The total number of features was simply a count of all features (both emergent and nonemergent) in a response for a given pair. This score was calculated separately for the first and second definitions of the similar and dissimilar pairs. Table 1 shows the mean values of the total number of features for both similar and dissimilar pairs for both the first and second attempts at defining the combinations. Participants' mean total number of features were analyzed using a repeated-measures analysis of variance (ANOVA). The analysis revealed no significant effects of pair similarity [$F(1, 63) = .09$, $p < .7652$], order of attempt at defining [$F(1, 63) = 2.08$, $p < .1543$], or their interaction [$F(1, 63) = 1.65$, $p < .2039$]. Thus, the effects obtained for emergent features are not simply a byproduct of the effect of similarity and definition attempt on the overall tendency to produce features of all types; rather, they are specific to the phenomenon of emergence.

Method of combination. To determine what methods of combination were used to define the pairs of words, the first author and a graduate student (naive to the purpose of the study) rated each definition as Relation Linking, Property Interpretation, Hybridization, or Other. An interpretation was coded as involving relation linking if the definition identified a thematic link between the two concepts, such that the concepts played complementary roles in the relation. For example, the definition "a *bowl* that serves as a storage place for *cups*" for the combination *cup bowl* identifies complementary roles for bowl and cup in a thematic relation connecting the two parent concepts. Property Interpretation was coded when a feature from one concept was projected on to the other concept. Examples of property interpretation include the definition "six-stringed harp" for *guitar harp*, which projects the six strings of an ordinary guitar onto a harp, and "slippery package" for *oil bag*, which projects the slipperiness of oil onto the bag. Hybridization was coded when the definition involved the combination of several features of both parent concepts or a complete blending of the two concepts. For example, when *dirt mud* was defined as "a combination of dirt and mud" or when *saw scissors* was defined as "a dual purpose tool that both cuts and saws" the definition was coded as a hybrid. Any definition that did not fit into any of these categories was coded as "other." Examples of definitions that utilized other combination methods are when *oil bag* was defined as "a lot of money" or when *couch skate* was defined as "a reversible cover on a couch." This coding scheme is based on one outlined in Wisniewski (1996).

Overall, the raters agreed on 86% of the definitions. These judgments were used in two different types of analyses. The first tested the effects of similarity and order of attempt at definition on the tendency to use each of the three major types of definition. The second evaluated the average number of emergent features for pairs that were defined using each method of combination.

To examine the effect of similarity and definition attempt on the extent to which each type of method occurred, three ratio values were calculated by dividing the number of times each method was used by the total number of definitions using any of the three major methods. For example, the extent to which property interpretations occurred was calculated as the ratio of the number of property interpretations to the number of property, hybrid, and relational interpretations.[2] The means for all of the ratio values are given in Table 2.

TABLE 2

Proportion (and Standard Deviation) of Definitions That Were Classified as Property Construction, Relation Linking, and Hybridization for Each Type of Pair and Each Definition Attempt

Type of pairs	Method	First definition	Second definition
Similar			
	Property construction	.53 (.25)	.53 (.21)
	Relation linking	.23 (.20)	.27 (.22)
	Hybridization	.25 (.20)	.20 (.18)
Different			
	Property construction	.43 (.17)	.46 (.18)
	Relation linking	.55 (.18)	.52 (.18)
	Hybridization	.02 (.05)	.03 (.05)

Each of the three ratios was examined in a 2 × 2 (similarity × order of attempt) ANOVA. In each case, the similarity of the pairs was found to be the only significant effect. Property Interpretations were significantly more prevalent for similar pairs than for dissimilar pairs [$F(1, 63) = 9.32$, $p < .003$], and the same was true for Hybridization [$F(1, 63) = 110.87$, $p < .001$]. In contrast, Relation Linking interpretations were more prevalent for dissimilar pairs than for similar pairs [$F(1, 63) = 113.05$, $p < .001$]. These results are consistent with those obtained by Wisniewski (1997a, 1997b) and with the predictions of his dual-process model.

[2] This method of calculating ratios excluded instances of "other" types of definitions because we had no initial theoretical prediction about the influence of the variables on the unclassifiable methods. The raw means for the number of times other methods were used are as follows: similar pairs, first definition = 1.61; similar pairs, second definition = 2.22; dissimilar pairs, first definition = .47; dissimilar pairs, second definition = .67.

To determine if there was a link between the method of combination and the level of emergence, the mean number of emergent features for each method of combination was determined for all combination types except "other." Means were calculated which preserved information about order of attempt at defining, and similarity, and can be found in Table 3.

Emergence scores were analyzed using a repeated-measures ANOVA to determine how emergence was affected by similarity, order of attempt at defining, and method of combination. To avoid missing data for cells in the design, only participants who gave at least one property interpretation and one relation linking definition for at least one similar and one dissimilar pair on first and second attempts could be included in the analysis. Because of the limited number of definitions using hybridization for dissimilar pairs, hybridization was dropped from this analysis. There was a significant effect of similarity [$F(1, 36) = 11.90$, $p < .001$] and of order of attempt at defining [$F(1, 36) = 12.01$, $p < .001$] (replicating earlier analyses), but no other effects were significant, indicating that the method used to combine a pair did not affect the level of emergence in the combination. In other words, although lower levels of similarity resulted in more emergence and more relation linking, there was evidently no direct link between the latter two variables. Low similarity did not produce more emergence *because* it led people to develop relation linking definitions.

TABLE 3

Mean Number (and Standard Deviation) of Emergent Features for Each Method of Combination

Type of pairs	Method	First definition	Second definition
Similar			
	Property construction	1.09 (0.77)	1.53 (1.03)
	Relation linking	1.31 (1.05)	1.83 (1.44)
Different			
	Property construction	1.66 (0.75)	1.96 (1.15)
	Relation linking	1.79 (0.85)	1.82 (0.87)

Note. Data in this table are from those individuals who gave a relation linking interpretation and a property interpretation for at least one similar and at least one dissimilar pair on a first and second attempt.

Rather, it appears to have produced each effect independently. Likewise, dissimilar pairs resulted in more emergence than similar pairs, regardless of whether the definition took the form of property interpretation or relation linking.

Examples of emergence. Our major focus was on the quantitative assessment of the number of emergent features that occur in interpretations of similar and dissimilar combinations rather than on a more qualitative treatment of the content of those interpretations. In addition, the variety of interpretations given for the pairs makes it difficult to summarize that content. However, some examples of emergent properties can help to illustrate the richness of participants' interpretations and their use of reasoning processes that led to those properties.

Several respondents defined "helicopter blanket" as something like "a cover for a helicopter," and they included emergent properties, such as camouflage, fitted, durable, waterproof, fireproof, and made of vinyl, plastic, or canvas. Similarly, interpretations of "motorcycle carpet" as something like "a place to park a motorcycle" or "a cover for a motorcycle" included emergent properties, such as cheap, tough, absorbent, waterproof, and chemically impervious. "Couch skates" interpreted as devices for moving furniture sometimes included properties such as durable, sturdy, efficient, and strong. These and other emergent properties appear to be logically reasonable modifications which participants included to allow the combined object to serve its specified role.

Sensible emergent properties were not limited to relation linking definitions (e.g., "pudding metal," interpreted as a soft kind of metal, was sometimes specified as flowing, light, and used to hold things together or fill empty spaces). And although, emergent properties were, overall, less common for similar pairs than for dissimilar ones, logically reasonable modifications are still present. For instance, several participants interpreted "sled skis" as specialized skis for a particular population of users (e.g., beginners, children, big people, and handicapped individuals) and incorporated properties, such as safe, easy to use/balance, wide, and comfortable. "Guitar harps" interpreted as harps having guitar properties or as combined instruments included a variety of emergent modifications to their size, shape, appearance, sound, or manner of play, and "drill hammers" interpreted as hybrid combinations of a drill and a hammer were sometimes specified as efficient, convenient, or time saving.

PHASE FOUR: CONTENT ANALYSIS OF CONCEPTUAL COMBINATIONS

Phase Three demonstrated that emergence is more prevalent in dissimilar pairs and on second attempts at defining the pairs. Our interpretation of these effects is that they are the outcome of an alignment process by which people initially establish commonalities, alignable differences, and nonalignable differences between the constituents of the combination (see, e.g., Markman & Gentner, 1993). Similar pairs are more readily aligned than dissimilar pairs. Consequently, the interpretations for the former are more likely than those for the latter to come from within that readily constructed aligned representation. In contrast, the less obvious alignments for the dissimilar pairs may require participants to rely on information from outside the aligned framework in an effort to develop a coherent interpretation (see, e.g., Wisniewski & Markman, 1993, for a related point).

If the differences in emergence that were observed between similar and dissimilar pairs and between first and second attempts at definitions are the result of a comparison and alignment process, then it should be possible to document links between those findings and the results from a task that directly taps the structural alignments of the pairs. In Phase Four, we examined pair alignments by having participants list commonalities and differences between the members of each of the pairs used in Phase Three, and we coded all listed properties for each pair as being "within-alignment" features for that pair. We then examined the content of the interpretations given in Phase Three to determine the extent to which they included those within-alignment features as opposed to other, "extra-alignment," features that were not listed in the comparison task. If our interpretation is correct, definitions given in Phase Three for similar pairs and for first attempts should be found to contain higher proportions of within-alignment features than definitions given for dissimilar pairs and second attempts. Conversely, because dissimilar pairs and second attempts may push people beyond the confines of the alignment, those definitions should contain more extraalignment features.

It is important to note that extraalignment features are not necessarily emergent in and of themselves. For instance, participants in Phase Two listed "downhill" as a feature for *ski*, so "downhill" would not be identified as an emergent feature in defining *computer ski* as "skiing downhill on a computer." However, if participants in Phase Four failed to list "downhill" as a commonality or difference between computer and ski (e.g., as in "skis go downhill, computers do not"), "downhill" would be classified as an extraalignment feature for the pair. It follows then, that while extraalignment features may be emergent ones, they are not necessarily so. We nevertheless expect that, corresponding to the higher levels of emergence for dissimilar pairs and second attempts, we will find more extraalignment features highlighted in those definitions.

To provide additional information about the role of alignment, we also classified within-alignment features as being commonalities (e.g., guitars and harps both have strings), alignable differences along a common dimension (e.g., guitars have six strings, but harps have many), or nonalignable differences (e.g., guitars have necks, but harps do not). Based on prior findings (e.g., Markman & Gentner, 1983) we expect to find that participants in the present phase will list more commonalities and alignable differences for the similar pairs and more nonalignable differences for the dissimilar pairs. More importantly, to the extent that an alignment process occurs during the comprehension of conceptual combinations, we should find that alignable differences are more prevalent in the Phase Three interpretations of similar pairs, whereas nonalignable differences are more prevalent in interpretations of dissimilar pairs.

Finally, we have assumed that variations in the similarity/alignability of the pairs influenced the likelihood and form of emergent properties for both property and relational interpretations, with the latter presumably occurring because a comparison process runs in parallel with scenario construction process (see Wisniewski, 1997b) and guides the modifications that are needed for the scenario to work. Consequently, we expect that the pattern of relatively more within-alignment features for similar pairs will be found for both property and relation linking interpretations. An alternative account of the connection between similarity and emergence in relation linking interpretations, however, is that the rated similarity of concepts can be influenced, in part, not just by their alignability but also by their potential thematic connections (see, e.g., Bassok & Medin, 1997; Wisniewski & Bassok, 1996). For instance, milk and cow are rated as more similar than and milk and horse, presumably because of the strong thematic relation between cows and milk (Wisniewski & Bassok, 1996). Thus, to the extent that our Phase One participants' ratings of similarity were influenced by the relational compatibility of the concepts, the greater emergence in relation linking interpretations of dissimilar pairs could conceivably be driven by their lower thematic compatibility rather than by their limited alignability. By this account, the pattern of relatively more within-alignment features and fewer extraalignment features for similar pairs would not necessarily be expected to hold for relation linking definitions.

Method

Participants. The participants were 22 Texas A&M undergraduates from the psychology participant pool, who received course credit for their participation. Because of a failure to complete the task properly, the data from two participants were dropped from all analyses.

Stimuli. The stimuli were the 16 word pairs that were used in the conceptual combination task. Each word pair was presented on a page of paper followed by either the word "commonalities" or "differences" in parentheses. Two types of packets were constructed from the pages. One type requested commonalities for eight randomly selected pairs (car milk, guitar harp, saw scissors, motorcycle carpet, pool puddle, couch skate, computer ski, and train trolley) and differences for the other eight pairs (pudding metal, sled ski, helicopter blanket, airplane puddle, oil bag, drill hammer, dirt mud, and cup bowl). The other type of packets requested differences for the pairs that had required commonalities in the first type and commonalities for the pairs that had required differences in the first type. The order of presentation of the pairs within each packet was randomized.

Procedure. The participants were tested in small groups, with half receiving each of the two packet types. They had 40 min to list commonalities for eight of the pairs and differences for the other eight.

Coding. All listed commonalities and differences were entered into a database of "within-alignment" features for each pair. Subsequently, the features that had been obtained from the definitions in Phase Three were classified as being in the database for each pair (within-alignment) or not in the database (extraalignment). In addition, responses from Phase Four were broken down into commonalities, alignable differences, and nonalignable differences using the following coding procedures. A commonality was identified as any listing that stated "both items have" or "both items don't have" some feature. Statements such as "both *trains* and *trolleys* are modes of transportation" and "both have wheels," for example, would be identified as commonalities.

Any response that identified a difference between the two items in a pair along some common underlying dimension was coded as an alignable difference. As recommended by Markman and Wisniewski (1997), alignable differences were coded for both explicit references to values along a single dimension, such as "a *sled* carries more than one person and a *ski* carries only one person," as well as for implicit references, such as "*sleds* and *skis* carry different numbers of people."

Nonalignable differences were coded for all other differences that were listed. These differences simply focused on a disparity between the two items without highlighting a common dimension. An example of a nonalignable difference would be "an *airplane* is solid but a *puddle* is not" or for the pair *helicopter blanket*, "a *blanket* can be homemade."

Results

Number of commonalities and differences. The mean numbers of commonalities, alignable, and nonalignable differences listed for similar and dissimilar pairs are shown in Table 4.

As expected, there were significant effects of pair similarity on all types of responses. More commonalities and alignable differences were listed for similar pairs than for dissimilar pairs [$t(19), = -6.27, p < .001$; and $t(19), = -3.41, p < .003$, respectively]. Conversely, more nonalignable differences were listed for dissimilar pairs than for similar pairs [$t(19), = 5.87, p < .001$]. These results replicate those found by Markman and Gentner (1993).

Content of Conceptual Combination Definitions. To assess the possibility that an alignment process led to the variations in emergence found in the definitions from Phase Three, we examined the proportions of features contained in those definitions that were within-alignment features (i.e., present in the within-alignment database obtained from Phase Four for each pair). That is, for each definition given in Phase Three, we divided the number of features from that definition that were identified as within-alignment features by the total number of features (within-alignment + extraalignment) included in that definition. The proportions of within-alignment features are shown in Table 5.

An ANOVA revealed that there was a significantly higher proportion of within-alignment features for similar than for dissimilar pairs [$F(1, 63) = 14.38, p < .001$] and a significantly higher proportion of within-alignment features for first than for second attempts at defining the combinations [$F(1, 63) = 31.24, p < .001$]. There was, however, no significant interaction of similarity and attempt ($F < 1$). The results parallel those obtained for emergent features in Phase Three and provide support for the idea that comparison and alignment processes underlie those differences in emergence.

In addition, we conducted a similar analysis that also included definition type (property versus relation linking) as a factor. As in the parallel analysis from Phase Three, only the responses of individuals who gave at least one property and relation linking definition for similar and dissimilar pairs on first and second attempts could be included. Otherwise, cells in the design would have had missing data points. Consistent with the analysis described in the previous paragraph, this analysis revealed a significantly higher proportion of within-alignment features for similar than for dissimilar pairs [$F(1, 36) = 7.23, p < .05$] and for first attempts than for second attempts [$F(1, 36) = 18.07, p < .01$], but no other significant effects. In particular, as is evident from the pattern of means in Table 6, there was no similarity × definition type or attempt × definition type interaction ($F < 1$) in both cases. The results are consistent with the idea that alignment plays at least some role in the emergence found for both property and relation linking interpretations. Thus, even though relation linking interpretations may be the result of a scenario construction process, the evidence suggests that an alignment process may also be at work simultaneously.

TABLE 4

Mean Number (and Standard Deviation) of Commonalities, Alignable Differences, and Nonalignable Differences Produced by Participants

Type of pairs	Commonalities	Alignable differences	Nonalignable differences
Similar	5.04 (1.38)	3.28 (1.54)	1.36 (1.35)
Different	2.39 (1.49)	2.25 (1.40)	3.49 (1.78)

TABLE 5

Proportion of "Within-Alignment" Features Found in Definitions for Each Type of Pair and Each Definition Attempt

Type of pair	First definition	Second definition
Similar	.81	.72
Different	.73	.67

TABLE 6

Proportion (Standard Deviation) of Within-Alignment Features for Each Method of Combination

Type of pairs	Methods	First definition	Second definition
Similar			
	Property construction	.80 (.22)	.70 (.26)
	Relation linking	.78 (.32)	.52 (.29)
Different			
	Property construction	.75 (.17)	.60 (.29)
	Relation linking	.60 (.14)	.53 (.24)

Note. Data in this table are from those individuals who gave a relation linking interpretation and a property interpretation for at least one similar and at least one dissimilar pair on a first and second attempt.

Although definitions for similar pairs and first attempts were found to contain higher proportions of within-alignment features, an alignment process during conceptual combination would also be expected to lead to a different balance among the types of within-alignment features for similar and dissimilar pairs. Specifically, because an alignment process would highlight alignable differences for similar pairs and nonalignable differences for dissimilar pairs, we would expect that definitions of similar pairs would contain a larger number of alignable differences and definitions of dissimilar pairs would contain a larger number of nonalignable differences. Separate ANOVAs confirmed that there were significantly more alignable differences for similar pairs (M = .98 alignable differences per definition) than for dissimilar pairs ($M = .65$) [$F(1, 63) = 37.95$, $p < .001$] and significantly more nonalignable differences for dissimilar pairs ($M = .76$) than for similar pairs (.35) [$F(1, 63) = 126.06$, $p < .001$]. Interestingly, both analyses revealed a decreasing reliance on that specific type of feature going from first to second attempts [$F(1, 63) = 7.55$, $p < .01$] for alignable differences and [$F(1, 63) = 10.50$, $p < .01$] for nonalignable differences. The findings indicate a shift away from within-alignment features regardless of whether those features are alignable or nonalignable differences. Finally, there were more extraalignment features in definitions of dissimilar pairs (.74) than in definitions of similar pairs (.54) [$F(1, 63) = 41.83$, $p < .001$] and more extra alignment features on second attempts than on first attempts [$F(1, 63) = 29.57$, $p < .001$], again indicating that people were more likely to be led outside the confines of the alignment when they attempted to interpret dissimilar pairs and when they attempted second definitions.

DISCUSSION

This research demonstrates the effect of similarity on emergence and on the methods people use for interpreting combinations. As predicted, emergence was less prevalent for similar pairs of concepts than for dissimilar ones. In addition, there were more definitions of similar pairs that took the form property interpretation and hybridization and more definitions of dissimilar pairs by way of relation linking. Second attempts at defining a given pair also produced more emergent properties, although this effect was somewhat more pronounced for similar pairs than for dissimilar pairs.

This pattern of findings suggests that a comparison or structural alignment process operates during the interpretation of conceptual combinations (see Wisniewski, 1997a, 1997b), and that the readily alignable structures of similar pairs allow a “quick fix” to the problem of interpretation. Comparing parent concepts that are similar to each other would reveal many commonalities and alignable differences (see, e.g., Markman & Gentner, 1993), which would facilitate the identification of a property of the modifier to project onto the head noun, thus increasing the likelihood of a property interpretation. The compatible structures also would reduce the need to modify either the projected property or the head noun in order to allow the property to be sensibly incorporated into the structure of the head noun and hence would decrease the likelihood of emergence.

In dissimilar pairs, which provide less readily alignable structures, there are fewer alignable properties that can be directly projected, and the dissimilarity of the parent concepts can help a scenario construction process identify different roles for the concepts to play in a thematic relation. Consequently, more relation linking definitions would be expected. Even if a property were identified to serve as the basis for a property interpretation, the otherwise conflicting structures of the dissimilar constituents would result in pressure to modify the property or head noun, construe the constituents in unusual ways, or pursue other extraalignment solutions to resolve potential conflicts and successfully incorporate the property into the head noun. Presumably, the comparison process would identify the conflicts and trigger reasoning mechanisms to resolve them (e.g., Hampton, 1997; Kunda et al., 1990), which would, in turn, lead to emergent properties.

Strong support for the view that an alignment process led to the pattern of results comes from the fact that definitions of similar pairs contained significantly higher proportions of features from within the alignments of the parent concepts than did the definitions of dissimilar pairs. Conversely, definitions of dissimilar pairs contained more extraalignment features. This is exactly what would be expected if the limited alignability of dissimilar pairs resulted in more pressure to go beyond the initial alignment to achieve a satisfactory definition. In addition, the fact that the same pattern held for property and relation linking definitions suggests that the alignability of the component concepts can play a role in determining the extent of emergence even when the definition takes the form of a constructed scenario. The result is consistent with the idea that comparison and scenario construction may run in parallel, as suggested by the dual-process account (see, e.g., Wisniewski, 1997b). Even if scenario construction "wins" so that the expressed definition takes the form of relation linking, the results of the competing alignment process can spill over into the outcome, and indeed, any differences that are identified (e.g., size, shape, and material composition) may help to determine the form of emergent modifications that are needed for the scenario to work. Finally, because an alignment process would highlight more alignable differences for similar pairs and more nonalignable differences for dissimilar pairs, the fact that definitions of similar pairs contained more alignable differences and definitions of dissimilar pairs contained more nonalignable differences also supports the involvement of alignment in conceptual combination.

The fact that there were more emergent properties on second attempts at defining the combinations can also be explained by appeal to an alignment process. In developing a first definition, participants would be expected to rely on the most direct alignment and to project a property that would require the least modification. When constructing a second definition, they would be left with either a secondary property from the same alignment or another alignment altogether, either of which might be less satisfactory and require more modification. The result would be fewer property interpretations and a higher probability of producing emergent changes. Once again, the alignment data support this interpretation, as there were more within-alignment features in first definitions, more extraalignment features in second definitions, and a shift away from both alignable and nonalignable differences in going from first to second definitions.

Whereas both emergence and type of interpretation were affected by similarity, there was no evidence of a direct link between those variables. That is, there were neither more nor fewer emergent properties in property interpretations than in relation linking definitions. Hence, despite the fact that ease of alignment may be responsible for the effects we see in the number of emergent features and in the types of interpretations given, it does not appear to be the case that differences in emergence are caused by differences in the ultimate form of the interpretation (e.g., relation linking versus property interpretation). Rather, it seems that differences in alignability lead independently to differences in emergence and in type of interpretation.

Although the relative frequency of property interpretations has recently been questioned (Gagne, 2000), and by extension the need for an alignment process, our results and those from earlier studies by Wisniewski suggest that an alignment process does operate during people's attempts to interpret novel combinations. Consequently, a complete model of conceptual combination will have to include some role for alignment. Indeed, our results imply that even when relation linking definitions occur, alignment may be at work, at least in influencing emergence. Thus, a preponderance of relation linking definitions in natural cases does not necessarily diminish the possibility that alignment plays a pervasive role in interpreting combinations.

Finally, although our focus has been on an alignment process and the differential alignability of similar and dissimilar concepts, it is clear that other factors come into play during the comprehension of conceptual combinations. For one thing, as originally envisioned, an alignment process alone could not yield relation linking definitions because it highlights corresponding properties and differences (e.g., that cars and motorcycles both have wheels but that the former have four and the latter have two). It does not highlight complementary properties in a way that would allow the comprehender to see a potential thematic relation between the modifier and head noun. Consequently, unless the alignment process can be extended in some way to allow it to provide information about role-filling capacity (e.g., Sifonis & Ward, 1998), additional processes, such as scenario construction, are needed for a full account of how conceptual combinations are interpreted. In addition, it appears that other aspects of a combination's constituents, such as the salience or distinctiveness of their features, can influence the nature of the interpretation that is made, over and above any variations in the alignability of those constituents (see, e.g., Bock & Clifton, 2000; Costello & Keane, 2000; Estes & Glucksberg, 2000). Thus, although we argue that alignment is a critical component of interpreting combinations, and that it influences the likelihood of emergence, we recognize that it is one component of a more complex process.

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