Comment and Reply

Similarity, alignment, and conceptual combination: Comment on Estes and Glucksberg

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In their paper "Interactive Property Attribution in Concept Combination," Estes and Glucksberg (2000) suggest an alternative to the alignment view of property interpretation—one based on salience and relevance of features. I suggest that alignment as well as feature salience and relevance are crucial to property interpretation. In making their claims, Estes and Glucksberg also assume that similarity has inverse effects on two important ways of interpreting combinations (i.e., property and relation interpretations). I show that this assumption does not generally hold and provide an alternative explanation for their results (one based on the plausibility of relation interpretations).

In their paper "Interactive Property Attribution in Concept Combination," Estes and Glucksberg (2000) suggest an alternative to the alignment view of property interpretation proposed in the dual-process account of conceptual combination (Wisniewski, 1996, 1997a, 1997b). In reply, I first describe the role of alignment in the dual-process account and Estes and Glucksberg's alternative approach—one based on the salience and relevance of features. I then critically evaluate the evidence that Estes and Glucksberg present for their view and suggest that it does not contradict the alignment approach. In the process, I offer a number of arguments for why alignment is crucial to conceptual combination.

A number of studies have shown that people interpret combinations in three basic ways (Wisniewski, 1996; Wisniewski & Gentner, 1991; Wisniewski & Love, 1998). *Relation interpretations* involve a thematic relation between the referents of the modifier and head nouns (e.g., *robin hawk* interpreted as "a hawk that preys on robins"). In *property interpretations*, people apply one or more properties of the modifier noun to the head noun (e.g., *robin hawk* interpreted as "a hawk with a dull red breast"). Thus, they treat the modifier as referring to one or more of its properties rather than to the entity typically named by the modifier (as in relation interpretations). *Hybrids* refer to a mixture of the two constituents (e.g., *robin hawk* interpreted as "a cross between a robin and a hawk") or

to a conjunction of the constituents as in the familiar combination *singer songwriter* (see also Hampton, 1987). Evidence also suggests that people produce combinations in discourse situations that have these types of meanings (Wisniewski & Love, 1998, Experiment 3).

Recently, Wisniewski (1996, 1997a, 1997b) proposed a dual-process account of these conceptually distinct types of interpretations. In one process people assign or bind the constituents of a combination to different roles in a thematic relation (see also Brachman, 1978; Murphy, 1988, for related proposals). For example, to interpret *robin hawk* as "a hawk that preys on robins," people bind *hawk* to the *predator* role and *robin* to the *prey* role. In order to bind a constituent to a role, one must assess whether the constituent matches the preconditions of that role. For instance, *robin* matches the preconditions of the *prey* role presumably because it is edible, weaker than the predator, and so forth.

In a second process, people *align* or put into correspondence representational elements of the modifier and head noun concepts. For example, to interpret *robin hawk* as "a hawk with a red breast," people may align *breast area* in *robin* with the corresponding area represented in *hawk*, *wings* in *robin* with *wings* in *hawk*, and so on. Importantly, applying this mechanism allows one to determine *where* new information is to be integrated into the combination and whether the property plausibly applies. For example, the alignment of *breast area* in *robin* with *breast area* in *hawk* determines where *red breast* is to be integrated into *robin hawk*. Also, by determining that hawks have breasts just as robins do, this alignment suggests that *red breast* can be a plausible property of *robin hawk*. Alignment was proposed to account for property and hybrid interpretations. However, other factors, including the diagnosticity of a modifier's features as well as the modifiability of properties in the head noun, influence property interpretation (Wisniewski, 1997a, 1997b, 1998).

The application of alignment to conceptual combination was inspired by models of metaphor, analogy, and similarity in which alignment plays a central role (Falkenhainer, Forbus, & Gentner, 1989; Gentner, 1983; Holyoak & Thagard, 1989; Markman & Gentner, 1993a; Medin, Goldstone, & Gentner, 1993). In the dual-process account, though, assumptions about alignment differ in some ways from those proposed in these other models. For example, it is not necessary for alignment to be an exhaustive process in which all representational elements of the modifier are placed into correspondence with representational elements in the head noun—as it is in some models of metaphors and analogy (Wisniewski, 1997b, p. 176).

As an alternative to the alignment view of property interpretation, Estes and Glucksberg (2000) suggest that

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property interpretations result when a salient property of the modifier coincides with a relevant dimension of the head noun concept. For example, "light" is a salient property having to do with the weight of *feather* whereas "weight" is a relevant dimension of *luggage* (i.e., it is a dimension on which people distinguish instances of *luggage*). Thus, people should recognize this correspondence and interpret *feather luggage* as "light luggage." On this account, alignment is not involved in property interpretation except in a restricted sense. In particular, the authors suggest that people align the salient feature of the modifier with the relevant dimension in the head noun because the former is a value for that dimension. They then incorporate the salient feature into the head noun dimension as its value.

As evidence for their claim, Estes and Glucksberg (2000) present a study in which they varied the salience of a property in the modifier and the relevance of a dimension in the head noun. They predicted that these factors would affect the tendency to produce property interpretations of novel combinations. More specifically, when a modifier has a highly salient property that coincides with a highly relevant dimension of the head noun concept (HH combinations; e.g., *feather luggage*), people should be more likely to produce a property interpretation than when that property is not salient in the modifier but relevant in the head noun concept (LH combinations; e.g., *cotton luggage*) or the property is highly salient in the modifier but not relevant in the head noun concept (HL combinations; e.g., *feather storage*). Estes and Glucksberg obtained this predicted pattern of findings.

Importantly, Estes and Glucksberg attempted to design their stimuli in such a way that the alignment view would make a different prediction about the relative tendency to produce property interpretations among the three types of combinations. In particular, given evidence that similarity between concepts facilitates alignment (e.g., Gentner & Markman, 1994; Markman & Gentner, 1993a, 1993b), the authors assumed that according to the dual-process account, increasing the similarity between the constituents of a combination should increase property interpretations. They also assumed that the dual-process account predicts that decreasing constituent similarity should increase relation interpretations. In other words, the effects of similarity on property and relation interpretations are the inverse of each other. On the basis of this assumption, they constructed HH, LH, and HL combinations such that, on the average, their constituents were equally similar among the three types and of low similarity. Thus, they suggested that according to the dual-process account, there should be about the same (low) number of property interpretations combinations and the same (high) number of relation interpretations for all three types of combinations—a result that clearly was not obtained.

However, as detailed below, the relationship between the similarity of the constituents of a combination and the tendency to produce property versus relation inter-

pretations is not straightforward. The assumption that the effects of similarity on property and relation interpretations are the inverse of each other does not hold and is not a prediction of the dual-process view. Thus, it is difficult to conclude that Estes and Glucksberg's results constitute evidence against the alignment view. More importantly, though, I will suggest that regardless of the interpretation of these findings, a less restrictive view of alignment than the one proposed by Estes and Glucksberg still appears necessary in conceptual combination.

What is the relationship between constituent similarity and the relative frequency of relation versus property interpretations? In general, the tendency to produce relation interpretations is *independent* of constituent similarity. In order to interpret a combination with a thematic relation, one must assess whether a constituent can plausibly play a particular role in that thematic relation. This plausibility depends on the extent to which the constituent matches certain preconditions for that role and is generally not relevant to the similarity between the constituents. As Wisniewski (1996) states,

in order for an object to be contained in a box, the object must be smaller than the box. As long as this precondition holds, most objects could be contained in boxes whether or not they are similar or dissimilar to boxes. Likewise, for one animal to prey on another, the prey must be edible for that animal, and probably weaker and slower. Again, these preconditions are generally independent of the similarity of the animal to its prey. (p. 446)

On the other hand, there is a special case in which relation interpretations depend on constituent similarity. In particular, very high similarity between constituents very often prevents relation interpretations. As Wisniewski and Love (1998) note,

In the case of combinations with highly similar constituents (e.g., whiskey and beer), it is often the case that a plausible relation does not exist between the constituents. ... In general, highly similar things tend to play the same role in a relation. Because highly similar things as so alike they also tend to share those characteristics which are required of the potential filler of a role. For example, both whiskey and beer can play the object role in the drink relation because they are both beverages that one can drink. However, in order to derive a plausible relation interpretation, the constituents must play different roles in the relation. Thus, *whiskey beer* cannot be interpreted with the *drink* relation because both constituents are plausible fillers for the (same) *object* role. (p. 180)

In contrast to the relative independence of the effect of constituent similarity on relation interpretations, the tendency to produce property interpretations is affected by constituent similarity. In order to apply a property of one concept to another, the concepts must be similar at least to some degree. This claim follows because properties often depend on other properties for their realization (e.g., Sloman, Love, & Ahn, 1998; Wisniewski, 1996). As a result, it is more probable that a property of a concept C_1 can apply to concept C_2 if C_1 and C_2 are similar,

because statistically C_2 is more likely to share the dependencies of that property—by virtue of its similarity to C_1 . To take an example from Wisniewski (1996, p. 442), interpreting a *hammer hatchet* as a “hatchet for pounding in nails” is plausible because the properties on which “pounding in nails” depends are generally shared by the similar *hatchet* (e.g., having a long handle, able to be grasped and lifted in certain way, etc.). In contrast, interpreting a *hammer saw* as a “saw for pounding in nails” is less plausible because it does not share the dependencies associated with a hammer’s function. Importantly, there must be some way of assessing the fit between the dependencies of a property in one concept with properties in the second concept in order to determine whether the property can plausibly apply to the second concept. Wisniewski (1996, 1997b) suggested that this assessment is carried about by alignment. In this example, a person would determine that the dependencies associated with “pounding in nails” in *hammer* align with corresponding properties in *hatchet*, in order to interpret *hammer hatchet* as a “hatchet for pounding in nails.”

Importantly, in the dual-process account, constituent similarity is not the only factor that influences property interpretations. For example, the diagnosticity of a modifier feature also influences whether it will be applied to the head noun. As another example, as Estes and Glucksberg note, Wisniewski (1996) found that subjects produce property interpretations for many combinations with *dissimilar* constituents. In their reanalysis of these data, Wisniewski and Love (1998, p. 180) found that property interpretations for dissimilar combinations tended to occur when there was no plausible thematic relation between the constituents but not when a plausible thematic relation did exist. Thus, in the absence of a thematic relation with which to link the constituents, subjects construct property interpretations. Wisniewski (1997a, 1997b, 1998) details a number of examples of how people produce property interpretations of dissimilar combinations via alignment.

To summarize, the process involved in producing relation interpretations is generally independent of constituent similarity and instead is facilitated by thematic role plausibility. In contrast, the process involved in producing property interpretations is generally facilitated by constituent similarity because the dependencies of the modifier property are likely to be shared then by the head noun concept; thus, the property can plausibly apply to the head noun concept. A number of studies have demonstrated this facilitative effect (see Wisniewski, 1996, Experiment 2; Wisniewski & Love, 1998, Experiment 1). In addition, property interpretations are influenced by other factors such as the implausibility of relation interpretations and the diagnosticity of a modifier’s features.

Given these observations, it is difficult to conclude that Estes and Glucksberg’s results provide evidence against the dual-process account of conceptual combination (and more specifically, alignment). Subjects may have pro-

duced many more relational interpretations for HL and LH combinations because their constituents could play plausible roles in thematic relations. This factor, coupled with low constituent similarity, could account for why there were so few property interpretations among these combinations. In contrast, HH combinations may not have had many plausible thematic relations. This lack of plausible thematic relations would explain why there were many more property interpretations for these combinations (even though these combinations had low constituent similarity). Thus, this pattern of findings is not inconsistent with the dual-process account of conceptual combination.

A closer look at Estes and Glucksberg’s stimuli suggest that relation interpretations may have been more plausible for HL and LH combinations than for HH combinations. To take some examples, these HL and LH combinations appear to have plausible thematic relations: *zebra trap* (a trap for catching zebras), *rock circle* (a circle of rocks), *nut bagel* (a bagel made of nuts), *fire spray* (a spray for putting out a fire), *stove drink* (a drink heated on a stove), *mirror cleaner* (a cleaner for cleaning mirrors), *applause lecture* (lecture that generates applause), *fossil controller* (someone who controls the market on fossils), *dictionary writer* (someone who writes dictionaries), and *feather storage* (a place for storing feathers). In contrast, the corresponding HH combinations appear to have less plausible thematic relations between their constituents: *zebra bag*, *rock bagel*, *fire drink*, *mirror liquid*, *thunder lecture*, *fossil executive*, *dictionary talker*, and *feather luggage*.

On the other hand, it is unlikely that this explanation is the full story. Estes and Glucksberg constructed their HH combinations so that the modifier had a salient property that coincided with a relevant dimension of the head noun. The great majority of these combinations were interpreted with this salient property of the modifier. Thus, Estes and Glucksberg’s findings do highlight the importance of property salience and dimension relevance in conceptual combination. They show how the coalescing of a salient property in the modifier with a compatible dimension in the head noun can lead to property interpretations. Again though, these important findings are compatible with the dual-process account. Constructs related to feature salience and relevant dimensions are also an important part of the dual-process view. The corresponding constructs are diagnosticity of modifier features and dependencies (described earlier).

Most importantly, though, one wonders whether feature salience of the modifier coupled with a relevant dimension of the head noun can determine property interpretations with an alignment process that is as restrictive as the one that Estes and Glucksberg propose. For example, early in their paper, the authors suggest that in interpreting *zebra clam*, the modifier provides the salient feature “black and white striped,” which then fills the COLOR dimension in the head concept. In this case, people

align "black and white striped" of *zebra* with the COLOR dimension of *clam* (presumably because they know that "black and white striped" can be a value of COLOR).

However, increasing evidence suggests that people do not derive property interpretations by aligning and filling a dimension in the head concept with a value of that dimension from the modifier concept (e.g., Barsalou, 1993, 1999; Solomon & Barsalou, 1999; Wisniewski, 1997b, 1998, 1999). For instance, the interpretation of *zebra clam* contains more than a specification of the color of the clam. Among other things, the interpretation refers to stripes on the exterior surface of a zebra clam and stripes that are much smaller than those of a zebra. But, how do people know where the stripes of a zebra clam go? One answer is that people align the body of a zebra with the shell of the clam and the exterior surface of the zebra with the exterior surface of the clam. It is these correspondences which indicate where the stripes of a zebra clam should go (i.e., on the exterior surface of the clam shell, just as the stripes are on the exterior surface of the zebra body). Furthermore, because of this alignment, subjects determine that a zebra clam cannot have stripes that have the size and spatial extent of those of a zebra. In putting *zebra body* into correspondence with *clam shell*, people determine that clams are much smaller than zebras and not of the same shape. Thus, it is necessary that their stripes take a different form than those of a zebra. Wisniewski (1997b, 1998, 1999) suggests how alignment, together with additional processes, constructs such different forms.

Instead of this alignment view, one might assume that people determine where the stripes of a zebra clam go on the basis of general world knowledge. For instance, people might reason that a zebra clam has stripes on the exterior of its clam shell because striped things generally have stripes on their exteriors and clams have exteriors. However, evidence suggests that people use *specific* knowledge of the modifier instead. Recently, Wisniewski and Middleton (1999) constructed pairs of novel combinations whose modifiers had a similar salient property but one whose spatial location varied in the two modifiers. For example, the modifiers in *bucket bowl* and *coffee cup bowl* both have handles but one is connected to the rim at the top of the bucket and the other to the side of the coffee cup. Subjects drew pictures of plausible referents of these novel combinations. The drawings tended to preserve the spatial location of the property in the modifier. So, subjects drew bucket bowls with handles connected to their openings at the top but coffee cup bowls with handles on their sides. These findings suggest that people are aligning specific aspects of the modifier concept with corresponding aspects in the head noun.

To summarize, Estes and Glucksberg provide evidence that highlights the role of feature salience and dimension relevance in conceptual combination. Any model of conceptual combination must incorporate these important factors into its processing assumptions. On the other hand, these factors are not the only ones that influence property interpretation. Thematic role plausibil-

ity indirectly affects property interpretation. Importantly, alignment appears critical to the construction of a property interpretation and its integration into the combination.

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