# Investigating Creative Language: People's Choice of Words in the Production of Novel Noun-Noun Compounds

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**Abstract**

The production of novel noun-noun compounds is a prime example of everyday linguistic creativity. What cognitive processes guide people's choice of words when they make up a new noun-noun compound? An experiment examined people's production of noun-noun compounds as names for novel objects. The results showed that people's choice of words in these novel compounds was influenced by the diagnosticity of properties in those objects. By contrast, people's choice of words did not seem to be influenced by the communicative precision of the resulting compounds. These results suggest that, in constructing novel compounds, people are guided by conceptual representation rather than communicative task.

## Introduction

The production of noun-noun compounds is a prime example of everyday linguistic creativity. Compounds such as *soccer mom* (a middle-class suburban mother) or *alpha geek* (the person in a workplace who knows most about computers) convey a lot of information in a concise and inventive way. How do people produce novel compounds such as these? What cognitive processes guide people's choice of words when they make up a new noun-noun compound? There has been much recent research on the cognitive processes of conceptual combination, which allow people to understand novel noun-noun compounds by combining their constituent words in meaningful ways (Costello & Keane, 2000, 2001; Gagné & Shoben, 1997; Hampton, 1987; Murphy, 1988; Wisniewski & Gentner, 1991). There has also been much work on the situations in which noun-noun compound production occurs, especially in child language (asking whether children create compounds to fill gaps in their lexicon, to mark contrasts, or to allow more precise communication; see Clark, 1987, Clark & Berman, 1984, Windsor, 1993). However, there has been little research on the specific cognitive processes involved in people's creation of novel noun-noun compounds. This paper attempts to address this gap.

This paper describes an experiment examining people's choice of words in novel noun-noun compounds. In this experiment participants are given a description of a novel object and asked to make up a noun-noun compound as a name for that object. The experiment examined the influence of property diagnosticity on people's compound production. Diagnostic properties for a concept are those which serve to identify members of that concept: a diagnostic property is one that most members of a concept have, but most non-members do not have. Previous research has shown that property diagnosticity is important in people's interpretation of compound phrases (Costello & Keane, 2001). In the current experiment, the novel object descriptions presented to participants are controlled for diagnosticity: some containing diagnostic properties for a given concept, others containing non-diagnostic properties. If diagnosticity also plays a role in compound production, then there should be a relationship between the diagnosticity of properties in a novel object description, and people's choice of words when producing compound names for that object.

The current experiment uses materials derived from Costello & Keane's (2001) study of diagnosticity in compound phrase interpretation. The first part of this paper describes this earlier study. The second part describes the current experiment examining the production of novel compounds. To foreshadow the results, this experiment found that diagnosticity was an accurate predictor of compound production: in the experiment the more diagnostic the property in an object description was for a given word, the more likely that word was to be used in generating a compound to name that object. An alternative factor, that of communicative precision (Clark, 1987, 1990), was not a reliable predictor of compound production. The final part of the paper links these findings to other research on concept combination and compound production.

## Diagnosticity in the Interpretation of Noun-Noun Compounds

How are people able to understand and grasp the meaning of a noun-noun compound which they have never seen before? When confronted with a novel noun-noun compound, people interpret that compound by combining the compound's modifier concept (the first word in the compound) with the compound's head concept (the second word). People can combine these two parts in a variety of different ways. Three main combination types have been recognised: conjunctive, relational, and property-transfer interpretations (Hampton, 1987; Murphy, 1988; Wisniewski & Gentner, 1991). In conjunctive interpretations people produce a combined concept that is an instance of both concepts being combined (e.g., "a *pet bird* is a bird which is also a pet"). In relational interpretations people assert a relation between the two concepts being combined ("an *apartment dog* is a small dog which lives in city apartments"). In property-transfer interpretations people create a new combined concept by transferring a property from the modifier concept to the head. For example, the compound "elephant pig" might be interpreted as " an *elephant pig* is a pig that has tusks": the transfer of a property from the modifier concept ("elephant") to the head concept ("pig"). These property-transfer combinations have been the focus of much recent research (Costello & Keane, 2001; Gagné, 2000; Wisniewski & Love, 1998). This focus in this paper is on property-transfer combinations.

Costello & Keane (2001) describe an experiment examining people's interpretation of property-transfer combinations. The

experiment was designed to test two differing predictions about these property-transfer combinations. One prediction was that the transferred property would be a structurally aligned difference between the modifier and head concepts; that is, a property in the modifier concept that structurally corresponds to a different property in the head (Wisniewski, 1996). The competing prediction was that the transferred property would be a diagnostic property of the modifier (source) concept; that is, a property that helps identify members of that concept and distinguish it from other concepts (Tversky, 1977; Costello & Keane, 2000). In this experiment, participants were shown 16 novel compound phrases, with 4 different property-transfer interpretations as possible meanings for each phrase. Using two pre-tests, the 4 interpretations for each compound were controlled and crossed for structural alignment and diagnosticity. For example, for the phrase "elephant pig" the 4 interpretations were

Elephant pigs are

- pigs that are big (diagnostic, aligned)
- pigs that are grey (non-diagnostic, aligned)
- pigs that have tusks (diagnostic, non-aligned)
- pigs that are an endangered species (non-diagnostic, non-aligned)

Participants were asked to judge how good or bad they thought each property-transfer interpretation was as a meaning for the compound phrase in question, and to rate the acceptability of each interpretation on a scale going from -3 to +3.

The results of this experiment showed that people's interpretation of property-transfer compound phrases was strongly influenced by the diagnosticity of the transferred property for the modifier concept in the combination. People reliably rated interpretations using diagnostic properties as acceptable, and those using non-diagnostic properties as unacceptable. There was a significant correlation between the acceptability of interpretations and the rated diagnosticity of the properties they contained. Structural alignment had no influence on people's interpretation acceptability ratings in the experiment. In a subsequent test participants were shown the same phrases and simply asked to write down their own interpretations. Again, diagnosticity, but not structural alignment, influenced people's interpretation of the phrases.

Costello & Keane's (2001) materials provide the basis for the current experiment on role of diagnosticity in people's production of novel compound phrases. Costello & Keane's materials were constructed as follows. First, 16 participants in a property-generation task produced lists of properties for the modifier and head concepts of the compounds used in the experiment. For the modifier concept in each compound, 4 frequently-listed properties were selected. The diagnosticity of these 4 properties was then obtained in a diagnosticity-rating task. Another set of participants were shown the selected properties, each property being paired with the modifier concept of the relevant compound. Participants were asked to imagine they were playing the game in which they had to help the other player to guess the concept shown. They were asked to rate how helpful each property would be in helping their partner identify the concept in question. For example, to assess the diagnosticity of properties for the concept "elephant", participants were asked to rate how helpful each of properties:

- are big
- are grey
- have tusks
- are an endangered species

would be in allowing their partner in the game to identify the concept "elephant". Participants rated the helpfulness of the properties on a 7 point scale going from -3 (not at all helpful) to +3 (very helpful). Diagnostic properties were those whose average rating was above 0 on this 7-point scale. Two diagnostic and two non-diagnostic properties were obtained for each modifier concept, and these properties were used to construct the 4 interpretations for the compound phrase in question. In the main experiment, participants rated the acceptability of these interpretations for those compound phrases. The next section describes how these materials were used to investigate the role of diagnosticity in the production of compound phrases.

## Diagnosticity in the Production of Noun-Noun Compounds

The previous section described an experiment showing that, in interpreting compound phrases, the property diagnosticity plays an important part. Is diagnosticity also important when people are producing, rather than interpreting, compound phrases? This section describes an experiment addressing this question.

In this compound production experiment, participants were shown descriptions of unusual objects and asked to generate compound names for those objects. The object descriptions used were selected from the interpretations used in the comprehension study. Each of the 16 phrases in the earlier experiment had 4 object descriptions as interpretations, two using diagnostic properties and two using non-diagnostic properties. In the current experiment one diagnostic and one non-diagnostic object description was selected for each phrase. Participants were given the object descriptions alone (and not given the compound phrases). They were then be asked to generate a two-word noun-noun phrase to name that object. For example, some participants were given the object description

- "a special type of pig that has tusks"

and asked to write down a two-word noun-noun phrase to name that special type of pig. Other participants were given the object description

- " special type of pig that is grey",

and asked to come up with a noun-noun phrase for that object. The question of interest was whether participants would produce the phrase which corresponded to that object in the earlier experiment; that is, whether participants would produce the phrase "elephant pig" as a name for "pigs that have tusks". Notice that in the object description the head word for the phrase in question is already given (participants already know that the object described is a type of pig, and so would most

likely use that word as the head of whatever phrase they produce). The focus of analysis in the experiment is therefore on people's choice of modifier word for the phrases they generate. Will people be more likely to produce the expected modifier for object descriptions containing diagnostic properties ("pigs that have tusks") than for those containing non-diagnostic properties ("pigs that are grey")?

## Method

**Participants.** The participants were 18 Dublin City University undergraduates who took part for course credit.

**Materials.** The materials were 16 sets of object descriptions. Each set contained two object descriptions both of which had the same target phrase consisting of a modifier and a head. (Appendix A shows all 16 sets of object descriptions and target phrases). One object description contained a diagnostic property for the modifier concept in that target phrase; the other object description contained a non-diagnostic property for that concept. Participants in the experiment saw one object description from each set. Participants did not see the modifier concept for the target phrase for that set. The factor of interest was whether participants would produce a phrase containing the target modifier concept. Object descriptions were taken from the materials of Costello & Keane's (2001) experiment on compound phrase comprehension. The framing phrase "a special type of.." was added to each object description (so that, for example, participants were asked to produce a noun-noun compound to name "a special type of pig that has tusks").

**Design.** All participants saw 16 object descriptions, one from each of the 16 object-description sets. Participants were randomly divided into two groups. The first group of participants obtained the diagnostic object descriptions from one half of the object-description sets and the non-diagnostic descriptions from the other half. The second group of participants obtained non-diagnostic object descriptions from the first half of the object-description sets and the diagnostic object descriptions from the other half.

**Procedure.** Each participant received a booklet consisting of an instruction sheet followed by 16 object-description sheets in random order. Each object description sheet had an object description at the top of the page, and three slots in which participants were asked to write down three noun-noun compound names for the object described at the top of the page. Each slot provided space for a modifier and a head concept Participants had 40 minutes to complete the task.

The instruction sheet explained to participants that they would be asked to read a set of object descriptions and to respond by writing down some noun-noun phrases which they thought would be good names for the objects described. Four examples of familiar noun-noun phrases were given, to illustrate the type of response required. These examples were marked with a tick, to show that they were the correct type of response (see Table 1). These examples involved various different relationships between the nouns in the phrase.

A pre-test showed that, when asked to produce compound phrases as names for object descriptions, participants sometimes simply reproduced a word from the description rather than coming up with a new noun-noun phrase (producing the compound name "tusked pig" for the object description "a special type pig that has tusks", for example). To avoid uninteresting responses of this type, instruction sheet stressed that, in producing a compound name for an object, participants should not simply reproduce the words used in the description of that object. Participants were shown four examples of compounds which simply reproduced terms from an object description (Table 2, below). These were marked by crosses to show they were incorrect responses.

**Table 1**. Examples of correct responses in instruction sheet.

| Special type of thing | Correct compound |
|---|---|
| a special bed with hot lightbulbs above it, giving the user a tan. | a "sun bed" ✓ |
| a special bike with strong rugged tyres and frame. | a "mountain bike" ✓ |
| a special padded glove which protects against heat. | an "oven glove" ✓ |
| a special lamp containing moving bubbles of hot, coloured oil. | a "lava lamp" ✓ |

## Results

The noun-noun phrases produced by participants for the object descriptions were analysed by counting, for each object description, the number of participants who produced that description's target phrase as a name for that object description. For the object description "a special type of pig that has tusks", for example, this would mean counting how many participants produced the target phrase "elephant pig" for that object description. Variations of the target phrase were allowed if they clearly included the target modifier; for example, if a participant produced a blending such as "ele-pig" for "a special type of pig that has tusks", that would be taken as an occurrence of the target phrase.

For each target phrase there were two object descriptions; one using a diagnostic property of the modifier concept, the other using a non-diagnostic property of the modifier. For each target phrase, one group of 9 participants saw one object description, the other group saw the other object description; thus each object description was seen by 9 participants. For the object descriptions containing diagnostic properties of the modifier concept, the target phrase was produced by 3 out of 9 participants, on average. For the non-diagnostic object descriptions, the target phrase was never produced.

**Table 2**. Examples of incorrect responses in instruction sheet.

| Special type of thing | Incorrect compound |
|---|---|
| a special bed with hot lightbulbs above it, giving the user a tan. | a "lightbulb bed" ✗ |
| a special bike with strong rugged tyres and frame. | a "rugged bike" ✗ |
| a special padded glove which protects against heat. | a "protective glove" ✗ |
| a special lamp containing moving bubbles of hot, coloured oil. | a "coloured lamp" ✗ |

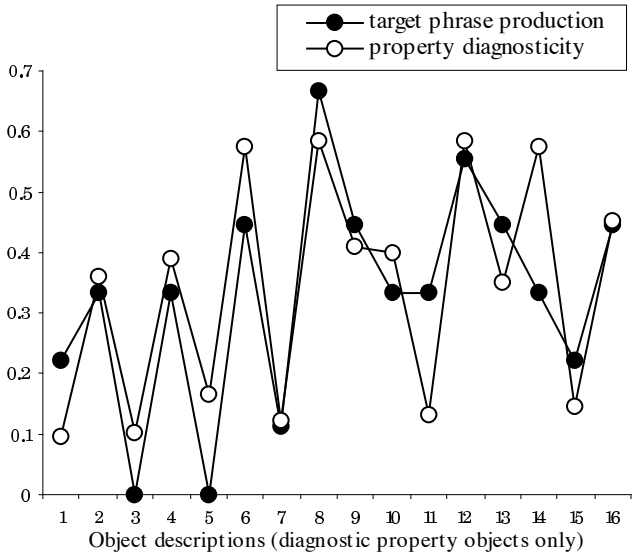


**Figure 1.** Probability of target phrase production for the 16 diagnostic-property object descriptions, and diagnosticity of properties for modifier in target phrase (diagnosticity mapped to probability scale).

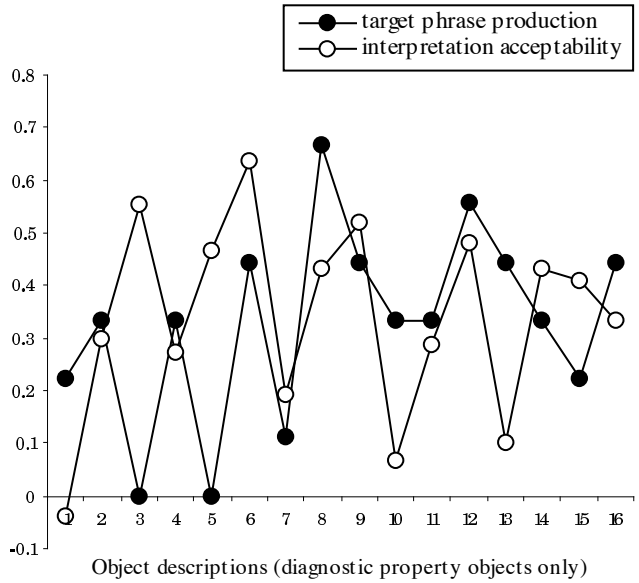


**Figure 2.** Probability of target phrase production for the 16 diagnostic-property object descriptions, and acceptability of descriptions as interpretations for phrases (acceptability mapped to probability scale).

**Results: diagnosticity.** The previous analysis showed that participants were clearly more likely to produce the target phrase for descriptions with diagnostic properties than for descriptions with non-diagnostic properties. A more detailed examination of the role of diagnosticity in compound phrase production was performed by analysing the relationship between the diagnosticity of properties in descriptions and the rate of target phrase production for those descriptions. This analysis was carried out for diagnostic-property descriptions only (the only descriptions for which the target phrase was produced). There was a significant correlation between the average rated diagnosticity of properties in these descriptions for the modifier concept (obtained from the pre-test for Costello & Keane's (2001) experiment), and the probability of target phrase production for those descriptions. The more diagnostic the property in an object description was for the modifier, the more frequently participants produced the target phrase ($r = 0.81$, $p < 0.001$, %var = 0.66). Figure 1 shows a graph of probability of target phrase production versus average property diagnosticity for the 16 diagnostic object descriptions. (In this graph property diagnosticity is mapped from its original rating scale of -3 to +3 onto the 0 to 1 interval on which probability of target phrase production is shown).

This result suggests that the production of novel noun-noun phrases for property-based object descriptions can be predicted from the diagnosticity of properties in those object descriptions. It might be argued, however, that the target phrase production in the experiment was not influenced by property diagnosticity per se, but by a more general association between the properties and concepts in question. For example, it could be that the phrase *elephant pig* was produced frequently for the object description "a special type of pig with tusks", not because having tusks is specifically diagnostic in identifying the concept *elephant*, but because there is a general association between elephants and tusks.

To address this possibility a general measure of association between concepts and properties was obtained from Costello & Keane's (2001) original property-generation task. In that task, 16 participants listed properties for the concepts used in the experiment. For each property and concept, the number of participants who listed that property as belonging to that concept was obtained. This number was taken to be a measure of the general association between the property and the concept. The correlation between this property-concept association and the rate of target-phrase production did not reach significance ( $r = 0.41$, $p > .1$, %var = 0.17). This suggests that it is diagnosticity specifically, rather than a more general association between properties and concepts, that is important for compound production.

**Results: Communicative accuracy.** In addition to examining the role of diagnosticity in compound phrase production, the current experiment allows us to examine the role of communicative precision in people's production of compound phrases. One view of compound production is that people produce novel compounds to allow them to precisely communicate their intended meaning to the listener (Clark, 1987, 1990; Clark & Berman, 1984). In this view, compound production is a listener-centered process: a person producing a compound as a name for a given object will choose a compound that the listener would easily interpret as referring to that object. If communicative precision is important in compound production, there should be a relationship between the rate at which people produce a given compound phrase as name for a particular object, and the degree to which people, when given that compound phrase, describe that object as the correct interpretation for the phrase.

The role of communicative precision in compound phrase production was analysed by comparing the rate at which people produced the target phrase for the given object descriptions in the current experiment against the degree to

which participants in Costello & Keane's (2001) study rated those object descriptions as good interpretations for those phrases. The correlation between the phrase production for a given description and description acceptability as an interpretation for that phrase was not significant ($r = 0.1$, $p > .1$, %var= 0.01). Figure 2 shows a graph of the rated description acceptability as interpretation and target phrase production. This finding of no relation between target phrase production and interpretation acceptability casts some doubt on the role of communicative precision in compound phrase production. This finding is in line with other results (e.g. Windsor, 1993; Elbers, 1988) which also call into question the communicative precision view of compound production.

## Conclusion

This paper has examined people's production of novel noun-noun compounds. Compound production is quite a creative linguistic task, with compounds often conveying a lot of information in an inventive way (as in the original *soccer mom* and *alpha geek* examples). The experiment reported here found that compound production is influenced by the diagnosticity of properties for concepts in compounds, but not by the communicative precision of those compounds. This is in line with other findings (Windsor, 1993; Eberts, 1988), suggesting that people's production of novel compounds is influenced more by their conceptual representations than by the communicative task that they are carrying out.

Why should diagnosticity play a role in people's novel compound production? Diagnostic properties are properties which help identify items and classify them as members of particular categories. Perhaps diagnosticity is important in compound production because in compound production the choice of words depends on judgements of category membership. According to this suggestion, when producing the phrase "elephant pig" as a name for the object description "a special type of pig with tusks", people use the diagnostic property "tusks" to classify the object described as to some extent falling into the category "elephant", thus allowing the modifier "elephant" to be used in forming the phrase. This is in line with Costello & Keane's (2000, 2001) proposal on the role of diagnosticity in compound interpretation. According to this proposal, when people interpret the phrase "elephant pig" as "a pig with tusks" they are asserting the diagnostic property "tusks" because it allows the newly described object to be classified under the category "elephant", hence justifying the compound (see Costello & Keane, 2000, for a computational model of implementing this approach).

How do the results reported here fit with other work on language production? The main stream of research on language production tends to use a "picture-naming" task to focus on people's production of words in response to a single concept. In this task people are presented with a picture of a single concrete object (e.g. a picture of a rabbit) and are asked to name that object. Models of language production in this framework typically have 5 stages: (i) Preliminary Analysis, (ii) Feature Recognition, (iii) Categorisation, (iv) Lexical Access, and (v) Decision (Bock & Griffin, 2000). The suggestion that diagnosticity is important in compound production because it related to judgements of category membership, fits nicely into the third Categorisation stage in this framework. Indeed, the findings of the current experiment suggest that property diagnosticity may play an important role in the Categorisation stage in this language production framework.

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**APPENDIX 1. Object descriptions and target phrases from Experiment**

| Description Set | Object description | | Target phrase (modifier head) |
|---|---|---|---|
| | **Property is diagnostic for modifier** | **Property is not diagnostic for modifier** | |
| 1 | A special type of chair that has blankets | A special type of chair that has wheels | Bed chair |
| 2 | A special type of moth that stings | A special type of moth that fertilises plants | Bumblebee moth |
| 3 | A special type of oak that stores water | A special type of oak that is completely green | Cactus oak |
| 4 | A special type of pig that has tusks | A special type of pig that is grey | Elephant pig |
| 5 | A special type of beetle that jumps | A special type of beetle that eats insects | Frog beetle |
| 6 | A special type of antelope that has a long neck | A special type of antelope that has a long tongue | Giraffe antelope |
| 7 | A special type of airplane that has horizontal rotors | A special type of airplane that is manuverable | Helicopter airplane |
| 8 | A special type of monkey that has a pouch to carry young | A special type of monkey that doesn't climb trees | Kangaroo monkey |
| 9 | A special type of lobster that has eight limbs | A special type of lobster found in warm waters | Octopus lobster |
| 10 | A special type of robin that can talk | A special type of robin that can be a pet | Parrot robin |
| 11 | A special type of horse that has a horn | A special type of horse that is very dangerous | Rhinoceros horse |
| 12 | A special type of squirrel that smells bad | A special type of squirrel that lives on the ground | Skunk squirrel |
| 13 | A special type of spider that has a shell | A special type of spider that eats plants | Snail spider |
| 14 | A special type of iguana that slithers | A special type of iguana that is used to make handbags | Snake iguana |
| 15 | A special type of slug that is poisonous | A special type of slug that is fast | Viper slug |
| 16 | A special type of seal that has a blowhole | A special type of seal that is an endangered species | Whale seal |