The effect of priming on preschooler's extension of novel words – how far can 'dumb' processes go?

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In the language development literature there are generally two differing ideas about the nature of the knowledge and processes involved in word learning. The rationalist approach posits that when extending a novel noun, children access knowledge about the referent's ontological kind and its central characteristics. For example, after observing Fido the Labrador being labeled "dog", children use their knowledge that Fido is an animal and that shape and texture are central characteristics of animals, to reason that other things of Fido-like shape and texture are also "dogs". According to the rationalist view, the processes children use to learn new words are deliberative and inferential, and the knowledge is conceptual, typically taking the form of logical propositions and rules (Gelman & Markman, 1987; Keil, 1994; Kemler-Nelson, Russell, Duke & Jones, 2000). In contrast, an approach in the empiricist tradition, the associationist account, suggests that children glean statistical regularities among perceptual features, category organization, and category labels. That is, for example, children implicitly learn that things that have eyes typically share names with other things of similar shape and texture. In this account, the processes involved are fast, direct and automatic, and the knowledge is perceptual and correlational (Smith, 1995; Smith, Colunga & Yoshida, 2003). Sometimes this debate has been framed in terms of whether children's early word learning is "smart" or "dumb", contrasting the reflective conceptual nature posited by the rationalists with the general-purpose automatic processes proposed by the empiricists.

It is important to note that these two accounts, although typically presented as opposing, are not mutually exclusive. First, the dichotomy as presented above confounds process with representation – deliberative processes and conceptual representations on the one hand versus automatic processes and perceptual representations on the other – but this needs not be the case. There can be automatic processes that operate on conceptual knowledge (Kemp & Tenenbaum, 2003; Colunga, 2004) or statistical processes that give rise to abstract representations (Colunga & Smith, 2003, 2005; Rougier et al, 2005). Second, it is also possible, as seen throughout cognition, there is a combination of automatic and rational thought operating at the same time, and a continuum of representational forms, from context-specific, perceptually-tied representations to more abstract, general or relational representations (Wallis et al, 2001). There is considerable evidence supporting the idea that associative processes play an important role in children's generalization of novel nouns (e.g. Colunga &

Smith, 2005), the question motivating this research is what are the bounds of these processes? This paper focuses on the Animate/Inanimate distinction as shown in children's novel noun generalizations.

A recent dispute in this literature offers an opportunity empirically examine these two ideas about knowledge and the processes that operate on them – unitary propositional concepts and thoughtful reasoning or correlations with automatic activations. In a novel noun generalization task, children are shown an exemplar like those in Figure 1. They are told its name, and then asked what other things have the same name. When shown an exemplar like that in Figure 1a, with cues indicating it is a depiction of an animate thing, children systematically generalize its name only to new instances that match in both shape and texture, but not to things that match in shape only or texture only. When shown an entity without such features, children systematically generalize the name to new instances that match in shape, whether they match in other properties or not, as shown in Figure 1b. Jones & Smith, (1993) and others have suggested that children learn correlations between features and category structure — between having eyes and being in a category organized by shape and texture, and between being angular (and without animacy features) and being in a category organized by shape. Consistent with theories and evidence on attentional learning, they suggest that in the novel noun generalization task, these features automatically increase attention to relevant properties, enabling children to attend to the right similarities according to the kind of the object at hand. This associationist account has been supported by showing that the requisite correlations between features and category organization exist across the first 300 nouns that children learn (Samuelson & Smith, 1999) and that these correlations are sufficient for an associative learner to abstract kind-specific biases that speed word learning (Samuelson, 2004; Colunga & Smith, 2005).

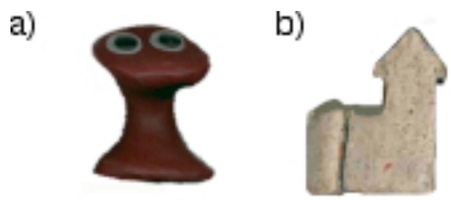

Figure 1. Examples of an exemplar with cues indicating it is a depiction of an animate thing, and an exemplar with artifact cues.

Recently, Booth and Waxman (2002) provided support for the alternative "smart" interpretation of children's performance in this task. Booth and Waxman presented exemplars in a context that construed them as animate or inanimate. The disambiguating context consisted of brief vignettes in which the experimenter gave the child information about the exemplar. For example, in the animate condition, the experimenter introduced an exemplar as a Teema and explained that the Teema has a mommy and a daddy that love it very much and give it hugs and kisses. In the artifact condition, the experimenters showed the same exemplar but this time introduced it as a Teema which is used by astronauts in their trips and will be replaced if it breaks. Their results showed that 3-year-olds can use the information in the stories to guide their generalizations of the novel noun — in the animate condition, children generalize the novel name for the exemplar to other objects matching in shape and texture, but in the artifact condition children generalized the novel name to any object that matched the exemplar on shape, whether it matched on texture or not.

We next consider two explanations of these results — one involving unitary propositions and rational inferences, the other correlations with trace history and automatic processing. Booth and Waxman take this result to mean that children word learning is "smart", a result of deliberative processes operating on conceptual knowledge in the form of an unitary concept of animacy and not directly dependent on correlations among perceptual properties. According to Booth and Waxman, the vignettes affect children's extension of novel nouns because they provide conceptual information relevant to the exemplar's ontological kind. That is, the animate vignette identifies the exemplar as a member of the ontological category of animate, and the artifact vignette identifies the exemplar as member of the ontological category of artifact. Once children know the ontological kind of the exemplar, they have access to all the knowledge regarding that kind, including the fact that shape and texture are central features for animates and shape is the central feature for artifacts.

The correlational learning account can also explain Booth and Waxman's findings through "dumb" processes of associative learning and automatic activation through spreading activation. According to this account, novel nouns are extended on the basis of learned correlations among perceptible properties. Having eyes correlates with having a mouth, correlates with being called "he" or "she", correlates with animate-like motion patterns, correlates with attention to shape and texture. This web of correlations could be the "knowledge" used in the novel noun generalization task through automatic processes, rather than through deliberative reasoning. Importantly, by this account any one cue can activate any other part of the web, *depending on the degree to which they have been correlated in the learner's experience*. Under this view, Booth and Waxman's results can be explained as a consequence of learned correlations among perceptible properties, including words. The vignettes shift children's attention because they are made out of words — words that correlate with categories of animates that are organized by shape and texture (like zebra, or snake) and words that correlate with categories of artifacts that are organized by shape (like hammer, or cup).

The next two experiments explore these issues. The first experiment tests whether the correlating words are enough to direct attention in kind-specific ways even when these words are not part of a vignette referring to the exemplar. The second experiment pits this "dumb" process against story understanding by using the correlating words in a story about the exemplar, but having the correlating words not refer to the exemplar.

1. Experiment 1

If the associationist account is correct, correlating words should cue attention to shape and texture in the animate condition and attention to shape in the artifact condition automatically, and without being strung together to form a coherent story *about* the exemplar. A strong test of this prediction would be to prime the children with animate-correlating or artifact-correlating words presented merely as a list and measure how this affects their performance in the novel noun generalization task. In contrast, Booth and Waxman's rationalist explanation would predict that merely reading to children these words in a list will not have an effect since they are not put together into a coherent story that presents conceptual information regarding ontological status, nor are they presented as referring in any way to the exemplar. Thus, if children's novel noun generalizations are shifted by this priming, this attentional shift will not be attributable to any kind of deliberative process that reasons about the ontological status of the exemplar using the information given by the experimenter.

1.1. Methods

Participants. 24 3-year-old children with a mean age of 42.6 months (range: 38.4-45-5 months) participated.

Materials. The stimuli consisted of two sets of eight abstract objects that could be construed as either animate or inanimate. Each set consisted of an exemplar object and 7 test objects that matched the exemplar in none, one, or more features of shape, texture or color. Figure 2 shows the diagnostic items, the ID test object matched the exemplar in all shape, color and texture features (but was different in size), there were also test objects that matched the exemplar in shape only, color only, texture only, shape + texture, shape + color, color + texture, and none of these features.

Two lists of words, one of animate-correlating words, the other of artifact-correlating words, were selected from the animate and artifact vignettes in Booth and Waxman (2002). Table 1 shows the words used.

Procedure. Children were randomly assigned to either the animate or artifact condition. During the Priming Phase, the child and the parent were asked to repeat the words said by the experimenter. The experimenter then went through the corresponding list saying each word once and letting parent and child repeat it. None of the test objects or exemplars were in view during the Priming phase. The Priming Phase was followed by the Testing Phase. The list of words was put away and children were informed that now they were going to play a different game and they were introduced to one of the exemplars "This is a Teema." and then asked for each of the test objects in that set "Is this a Teema?". Each of the test objects were presented twice in one of two previously generated random orders. Then the second set was presented, preceded by a second Priming Phase, for a total of 28 trials. The order of the sets was counterbalanced across conditions.

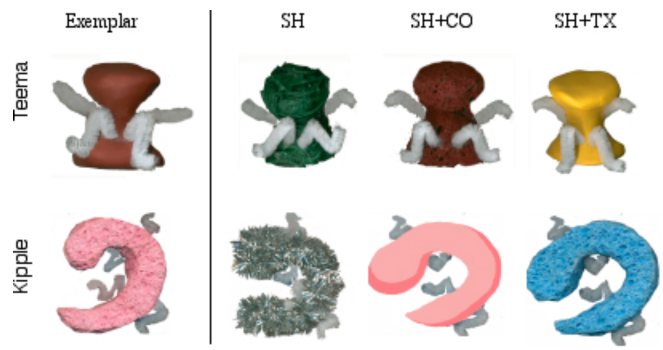

Figure 2. The two exemplars and some of their corresponding test items.

Table 1: List of animate-correlating and artifact-correlating words selected from Booth & Waxman (2002).

Animate	Artifact
mommy	take
daddy	worn
love	break
sleep	make
hugs	bought
kisses	use
hungry	
walking	
gobbled	
happy	

1.2. Results

The number of "yes" responses (the name applies) was submitted to a 2 (Animacy) x 7 (Test Item) repeated measures ANOVA. The analysis revealed a main effect of animacy ($F_{(1,22)} = 5.38$, $P < .05$). That is, children overall said "yes" more when primed with the artifact list of words than when primed with the animate list. There was also a main effect of test item ($F_{(1,22)} = 37.21$, $P < .001$). No interactions were significant.

Furthermore, post-hoc analysis revealed different patterns of noun extension in the two conditions. As shown in Figure 3, children in the animate condition extend the name to the ID test object and to the shape+texture match, whereas children in the artifact condition extend the name to the ID test object, the shape-only, the shape+texture and the shape+color matches. We counted the number of children who said "yes" more than expected by chance on each condition. On the critical test item, the shape-only match, there was a significant difference on the number of children who said "yes" more than expected by chance in the animate versus the artifact condition ($X^2(1, N=24) = 4.19$, $P < 0.05$). That is, children in the artifact condition extended the name of the exemplar to all the test objects that matched it in shape, regardless of their size, color or texture, but children in the animate condition extended the name of the exemplar more conservatively, only to those test objects that matched it in both shape and texture.

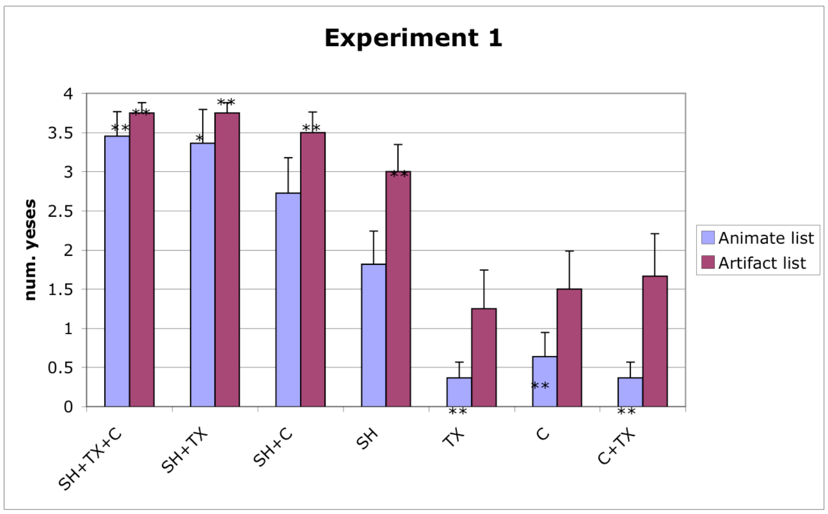

Figure 3. Results for Experiment 1.

1.3. Discussion

At the very least, the results of Experiment 1 showed where the information about animacy and artifact status is located in Booth and Waxman's vignettes. Simply hearing these words, without having them part of a coherent story about the exemplar, was enough to shift children's attention to features typical of animate vs. artifact categories – shape only for artifacts, shape+texture for animates. More importantly, children's novel noun generalizations were influenced by these words in a priming paradigm, without these words being heard at the same time that the exemplar or test objects were present. Apparently, these words automatically activate the attentional biases with which they are associated, a fact consistent with well-supported ideas about memory processes. Therefore this result supports the idea that children's novel noun generalizations depend on automatic processes that operate on learned associations.

However, language is much more than just a collection of words. Compositionality, combining words to form new meanings, is one of the aspects of language that give it its great power (e.g., Spelke, 2003). What a bunch of loose words do to children's attention may have little to do with what children actually do in real life when they learn words as part of a regular conversation. Perhaps a more naturalistic test of these ideas would be present the exemplars with vignettes, like Booth & Waxman did, and load them with correlating words in a story, but have these words not be about the exemplar. For example, the story could contain the words *mommy*, *hugs* and *kisses*, but it is a boy who has a mommy and gets hugged, rather than the exemplar, the Teema. If understanding the ontological status from these stories is what drives children's performance in this task, one would expect these words to have no effect when they are clearly used in the story to talk about something else and not the exemplar. However, if children's attention is shifted automatically, without much use of deliberative and rational thought to infer the meaning of the word, then one would expect an effect of animacy-correlating and artifact-correlating words even when it is clear from the story that they are not about the exemplar. Experiment 2 tests this idea.

2. Experiment 2

2.1. Methods

24 3-year-old children with a mean age of 43.2 months (range: 40.1–45.8) months) participated.

Materials. The stimuli were the same as in Experiment 1. Additionally, the words in the two lists of Experiment 1 were used as part of stories as seen in Table 2.

Table 2. Sample vignettes used in Experiment 2.

Animate-correlating	**Artifact-correlating**
Mommy went to the store and bought this *kipple* for my birthday. 'Happy Birthday!', they said, as they gave me lots of hugs and kisses. Then I went to sleep and dreamed of eating cake and playing with my new *kipple*."	Danny made this *kipple* for his mom's birthday. He spent 2 days painting it and wrapping it. Danny's mom opened the package and found her new *kipple*. Then she put it high on a shelf.

Procedure. Participants were randomly assigned to one of two conditions: animate and artifact. The procedure was much like Experiment 1 except that each exemplar was introduced using one of the stories shown in Table 2. After the exemplar was introduced, the testing phase proceeded just as in Experiment 1, by asking about each of the test objects whether it was also called by the same name as the exemplar or not. Each participant saw both sets and the order of the sets was counterbalanced across conditions. As in Experiment 1, each participant was queried on each of the 7 test-objects twice, for a total of 28 trials.

2.2. Results

The number of "yes" responses (the name applies) was submitted to a 2(Animacy)x7(Test Item) repeated measures ANOVA. The analysis revealed a main effect of test item ($F_{(1,132)} = 88.534$, $P < .001$). There was no main effect of animacy ($P = 0.18$). There was a significant Animacy X Test Item interaction ($F_{(6,132)} = 2.209$, $P < 0.05$). Planned post-hoc analyses revealed different patterns of noun extension in the two conditions. As shown in Figure 4, children in the animate condition extend the name to the ID test object and to the shape+texture match, whereas children in the artifact condition extend the name to the ID test object, the shape-only, the shape+texture and the shape+color matches, that is anything that matched in shape. Post-hoc comparisons (Tukey's HSD =.16) suggest that the reliable interaction results from the differences between the performances in the critical test item, the shape-only match, in the animate and artifact conditions. Additionally, there was a significant difference on the number of children who said "yes" more than expected by chance in the animate versus the artifact condition ($X^2(1,N=24) = 2.67$, $P < 0.05$). That is, children in the artifact condition extended the name of the exemplar to all the test objects that matched it in shape, regardless of their size, color or texture, but children in the animate condition extended the name of the exemplar more conservatively, only to those test objects that matched it in both shape and texture.

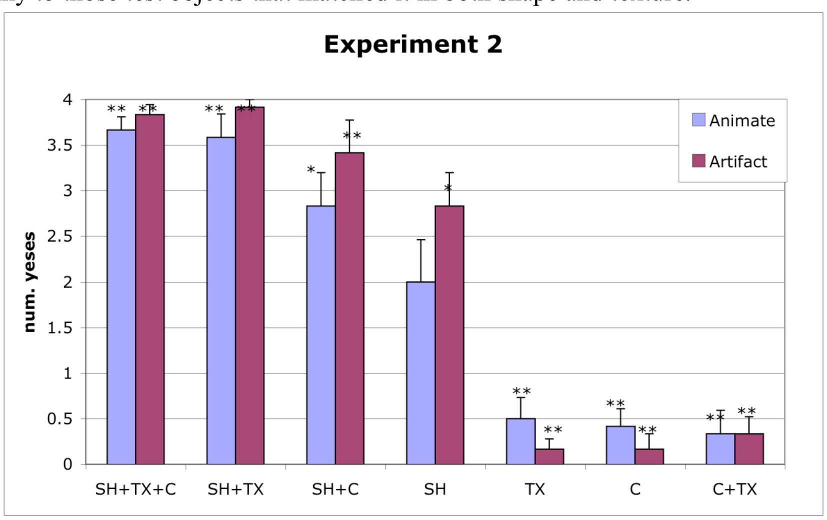

Figure 4. Results for Experiment 2.

2.3. Discussion

As expected from the associationist account, children show differing patterns of generalizations when animacy-correlating and artifact-correlating words are present in stories talking about the exemplar, even when those words are *not* used to talk about the exemplar. This suggest that in this task, it is the automatic effects of words and their correlations with perceptual features, words, and history of influencing attention which guides children's generalizations of novel nouns.

3. General Discussion

Put together, the results of the two experiments support the idea that automatic processes can guide word learning. The results of Experiment 1 showed that just listening to a list of words correlated with animates (or a list of words correlated with artifacts) is enough to shift children's attention to the features that typically organize categories of animates (or artifacts). The fact that the lists of words -- without forming complete sentences, without referring to the exemplar, without even co-occurring with the exemplar – can shift attention in kind-specific one does not need to appeal to any form of deliberative reasoning on the party of the child to understand why vignettes may shift children's attention in a novel noun generalization task. It could be, however, that when given complete sentences forming coherent stories, children do take advantage of that information and more deliberative processes that work on this more propositional information are invoked, but the results in Experiment 2 suggest this is not the case. This does not mean, of course, that more deliberative, rational processes have no place in young children's cognition. It is possible that a different task would yield different results. For example, if the task were to make inferences about the exemplar, or things like it, rather than generalize its name, being told more explicitly that it is to be construed as an animate might lead to more sound reasoning than what associative networks of correlations can support. However, it seems that when it comes to extending a novel noun, children rely on automatic processes rather than more deliberative processes. Further experiments are necessary to determine when this more "conceptual" knowledge is used in extending a novel noun and in other tasks.

But what does this say about the nature of the knowledge and representations used by children when learning a new word? Is early word learning conceptual or perceptual? The results of the two experiments here could be explained as automatic processes of priming operating on what is essentially conceptual information. After all, in a way, this is just an instance of semantic priming. A number of theorists have argued against the utility of the perceptual-conceptual distinction in children's categorization and beyond. For example, Goldstone and Barsalou (1998) argue that perception and conception cannot be completely separated; instead, perception is itself a product of category learning and an implementation of conceptual knowledge. Similarly, Ahn and Luhmann (2002) suggest that conceptual information is ultimately grounded in perception, and that what matters is not the *content* of knowledge, but its *structure* – causal, inferential or propositional versus correlational, associative and similarity based. In this regard, a more fruitful question than, "Is early word learning conceptual or perceptual?" would be to tackle the development of more or less complex structures based on more or less abstract experience. The associationist account allows us to do just that and further suggests that what we think of as more "conceptual" knowledge may be, at the end, a web of correlations, that includes perceptual features, words, category structure, contexts, and so on.

Extending a novel noun in ways consistent with the ontological kind of its referent is certainly a "smart" thing to do – it allows word learning to proceed quickly and carves the world into useful partitions. However, this "smartness", at least early in development, may be the product of "dumb", unthinking, but quick and efficient processes such as associative learning and generalization by similarity.

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