JoVE: Science Education

Categories and Inductive Inferences

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Corresponding Author:	Judith Danovitch UNITED STATES
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	
Corresponding Author's Secondary Institution:	
First Author:	Judith Danovitch
First Author Secondary Information:	
Order of Authors:	Judith Danovitch
	Nicholaus Noles
Order of Authors Secondary Information:	

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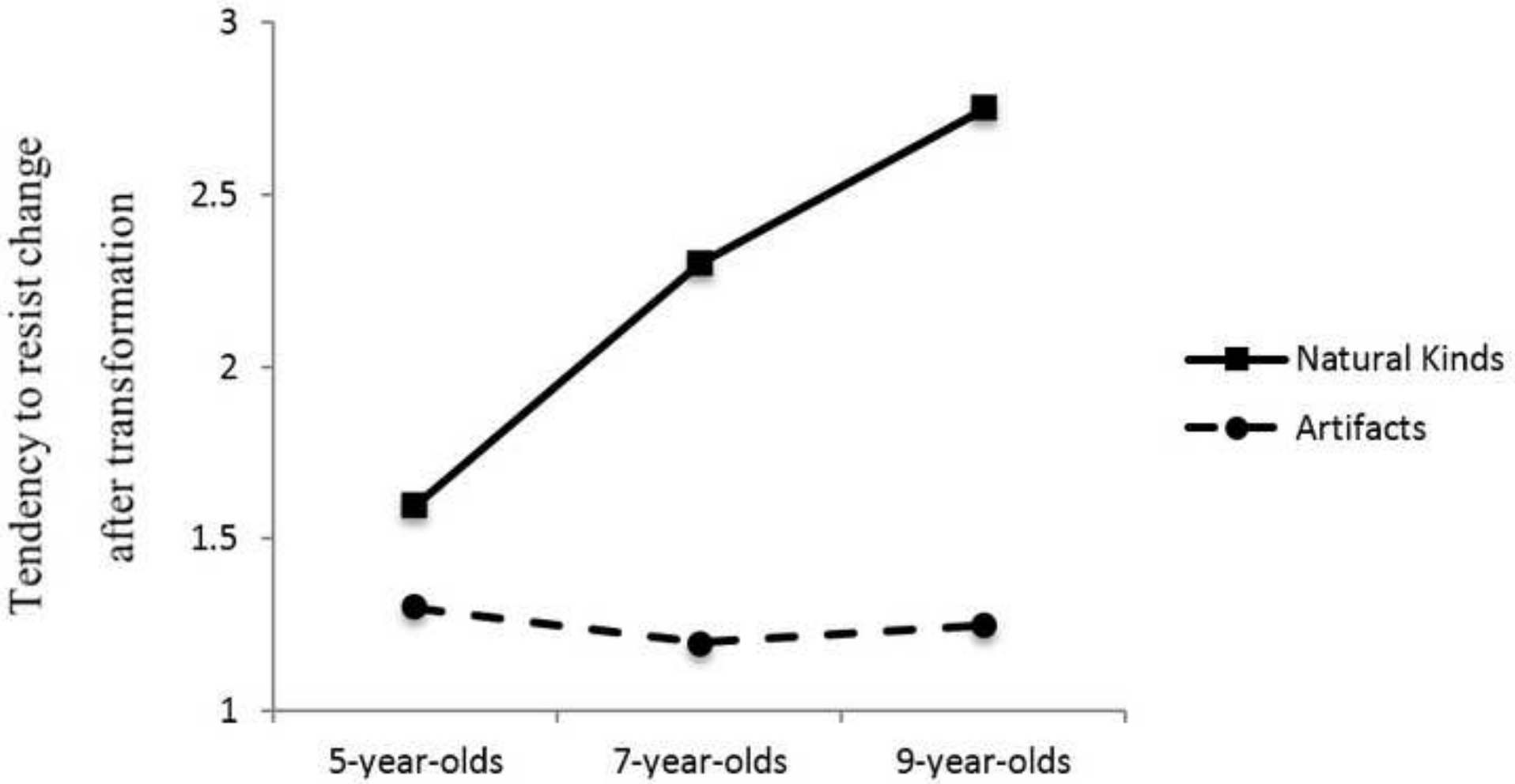

PIs: Nicholaus Noles and Judith Danovitch
Psychology Education Title: Categories and Inductive Inferences

Overview:

It might be possible for the human brain to keep track of each individual person, place, or thing encountered, but that would be a very inefficient use of time and cognitive resources. Instead, humans develop categories. Categories are mental representations of real things that can be used for a variety of purposes. For example, individuals can use the perceptual features of animals to place them into a given category. So, upon seeing a furry, four-legged, tail-wagging, barking animal, a person can determine that it is a dog ~~(**Figure 1**)~~. This is one of many examples where people use perceptual similarity to fit new experiences into their existing mental representations.

However, category membership is much more than skin-deep, especially for representations of animals. Frank Keil demonstrated this by using a simple, yet powerful, technique that focused on the differences between natural kinds and artifacts. Natural kinds include animals and other living things, while artifacts consist largely of non-living things, such as tables or gold bricks. In his study, Keil told children stories about natural kinds and artifacts that underwent transformations, causing them to cross categorical boundaries. For example, he described a step-by-step process by which a raccoon was transformed into a creature that resembled a skunk in every way. At the end of the story, the raccoon was black with a white stripe, and it had implanted glands that made it smell like a skunk, too. He asked the children to determine whether the resulting animal was a raccoon or a skunk. He used a similar method to describe the transformation of a tire – an artifact – into a shoe ~~(**Figures 2 and 3**)~~. Children's responses revealed interesting developmental changes into how people think about artifacts and natural kinds.

This video demonstrates Frank Keil's (1989) transformation study.

Procedure:

1. Recruit healthy 5-, 7-, and 9-year-old children with normal hearing and vision and no history of developmental disorders. For the purposes of this demonstration, only one child is tested. Larger sample sizes (as in Frank Keil's (1989) transformation study) are recommended when conducting any experiments.

2. Data collection.

    2.1. Gather the necessary materials.

        2.1.1. Design 8 vignettes describing the transformation of animals from one kind to another via surgery.

Commented [NN1]: For the purpose of the video, it is our expectation that only two vignettes (raccoon to skunk and coffeepot to bird feeder – the two we described in detail) would be shown. It sounds like Dennis is interested in illustrating more than the examples that we presented. We added a list of the vignettes at the end of the document with the descriptions of the transformations used in the original studies for reference. We don't have a strong intuition about how many should be included or how hard they are to generate, so we'll just put this information there for whomever to use.

Commented [DM2]: Jacob references this in the legend, but images 1-6 are all stock, and before we go and download (pay) for them, we wanted to make sure they'd be used. Please let us know how you want us to proceed.

Commented [NN3]: We added these to provide a variety of images for the JOVE production folks to use in supporting dialogue about the study. However, since it sounds like they may be illustrated instead, then that number can shrink or grow based on scripting. We're happy to defer to the professionals.

Commented [JS4]: I don't think it's necessary to include the photos referenced as figures. We will illustrate them for the transformation animations.

2.1.1.1. Natural kind vignette example, “The doctors took a raccoon ~~(Figure 4)~~ and shaved away some of its fur. They dyed the rest of the fur black. Then, they bleached a single white stripe down the center of its back. They surgically added a sack of super smelly stuff into its body, just like a skunk has. When they were all done, the animal looked like this ~~(Figure 4)~~. After the operation, was this a skunk or a raccoon ~~(Figure 4)~~?”

2.1.2. Design 8 vignettes describing the transformation of artifacts from one kind to another via physical alteration.

2.1.2.1. Artifact vignette example, “The doctors took a coffeepot that looked like this ~~(Figure 5)~~. They sawed off the handle, sealed the top, took off the top knob, sealed the spout, and sawed it off. They also sawed off the base and attached a flat piece of metal. They attached a little stick, cut a window in it, and filled the metal container with bird food. When they were done, it looked like this ~~(Figure 6)~~. After the operation, was this a coffeepot or a birdfeeder ~~(Figures 5 and 6)~~?”

2.1.3. Create cards with images of each item before and after transformation.

2.2. Preamble.

2.2.1. Present the child with a preamble, introducing doctors and describing operations and surgery.

2.3. Test.

2.3.1. Present the child with each of the 16 vignettes in a random order.

2.3.2. If children try to give an ambiguous response (*e.g.*, “It’s both” or “It’s a ~~S~~skuncoon”), ask them to pick one of the two highlighted responses.

2.3.3. Question the child in a free-form manner in order to understand what aspects of the vignette guided their responses. For example, the experimenter might ask questions like, “Why is it a birdfeeder?” or, “If the animal looks like a skunk and smells like a skunk, why did you say it was a raccoon?” This questioning helps to determine what features or principles the child uses to guide their intuitions.

2.3.4. Record the child’s responses, and then transcribe them for future analysis.

3. Analysis.

Commented [DM5]: Would be great if we could animate these transformations to illustrate the concepts. The authors will have the actual vignettes on hand so we can show those as well.

Commented [JS6]: Can you provide a list for the 16 vignettes shown?

Commented [NN7]: See the end of the document for a full list of vignettes. Let me know if you need text to go along with them, but that text will be very similar to the items listed above.

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Commented [JS8]: Can you provide a sample response that was transcribed for a score of 1 and 3?

Commented [NN9]: I added this in the Analysis section on coding below.

3.1. Two independent coders read the child's transcriptions and code them on a scale from 1 to 3 for each item. This score is an index of the child's resistance to categorical change.

3.1.1. A score of 1 on an item means a child shifts their intuitions to follow the transformation operation. These responses focus on characteristic features.

3.1.1.1. Example: "It's stinky and ~~stripy~~stripy like a skunk, so it's a skunk."

3.1.2. A score of 2 on an item means a child's responses are indecisive, indicating that they are unsure if the transformation results in a change in the item's kind.

~~3.1.1.2.~~3.1.2.1. Example: "It's a rac-unk or a s~~S~~koon. I don't know."

3.1.3. A score of 3 on an item means that a child resists shifting their intuitions following transformation operations. These responses contrast with observed features.

~~3.1.1.3.~~3.1.3.1. Example: "It doesn't matter what it looks like on the outside~~;~~ it's still a raccoon."

3.2. Use an analysis of variance to determine if there are differences between the three age groups and two types of items presented to the children.

Representative Results:

In order to have enough power to see significant results, researchers would have to test at least 18 children in each age group. Typically, when asked about artifacts, children in all three age groups conclude that what is seen confirms the categorical placement. If a tire is transformed into a rubber shoe, then it is a shoe and not a tire. In contrast, children presented with natural kinds reveal a developmental trend. 5-year-olds are either indecisive or see an animal's post-transformation features as indicating their category membership. As children get older, they determine increasingly often that animals remain the same kind of thing in spite of any physical transformation they may undergo. This experiment demonstrates that children represent category membership as an internal, unchangeable aspect of animals increasingly as they get older, and this idea drives children's intuitions about category membership (**Figure 1~~7~~**).

Applications:

Frank Keil's work demonstrates that internal characteristics count. Children treat category membership as springing from internal characteristics that cause animals' appearance and behaviors, and children continue to have the intuition that animals belong to their category, even when appearances and behaviors change. Generally, this finding supports other work demonstrating that children use categorical information and not other cues, such as appearance, to guide their inferences about animals. For example, individuals can use categories to make inductive inferences, or educated guesses, based on their categorical knowledge. So, if a child

knows it's dangerous to touch their pet cat when its tail is wagging, then they can make an inductive inference that any new, tail-wagging cat is also dangerous ~~**(Figure 8)**~~. These inferences, like the inferences of category membership in Keil's study, are driven by category membership and not necessarily appearance.

Legend:

Figure 1~~7~~: The average tendency for children to resist shifts in category membership. Low numbers indicate that transforming a target's features changes its category membership.

References:

Keil, F.C. (1989). *Concepts, Kinds, and Cognitive Development*. MIT Press: Cambridge.

Additional Vignettes Topics:

Sheep/Goat
Horse/Zebra
Diamond/Pearl
Lead/Gold
Grapefruit/Orange

Kitchen pipe/Flute
Playing c~~C~~ards/Toilet ~~P~~paper
Plastic m~~M~~ilk b~~B~~ottle/~~Flipflops~~Flip-flops
Garbage can/C~~c~~hair
Bobby pin/N~~n~~eedle
Tie/Shoelace

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