

# Role of Attention in the Formation of Illusory Correlations Among Preschoolers

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## Abstract

A large body of research shows that adults will form illusory correlations in the course of category learning. Surprisingly little research has examined illusory correlations among children. Two experiments examined the formation of the illusory correlation in 3- and 5-year-olds. Experiment 1 provides evidence that these young children will not form illusory correlations in a novel categorization task. Results from experiment 2 indicate that eliciting an attentional shift caused younger children to form an illusory correlation. These results are the first to show that the tendency to form illusory correlations occurs early in development. Furthermore, these results have important implications regarding the mechanisms responsible for illusory correlations.

**Keywords:** cognitive development; illusory correlation; statistical learning

## Introduction

People tend to form categories that adhere to regularities in the environment (Anderson, 1991; Pothos & Bailey, 2009). However, there are occasions in which people form categories that violate regularities in the environment. For instance, the so-called *illusory correlation* (IC) occurs when infrequent properties are associated with uncommon categories, despite the absence of such a relationship (Chapman, 1967). The present study explores the developmental origins of this apparent categorization bias.

Hamilton and Gifford (1976) provided a classic demonstration of the illusory correlation. Participants read descriptions about individuals from either a common (e.g., a novel category with 26 members) or rare category (e.g., a novel category with 13 members). One of two properties was attributed to each individual, such that one property was more frequent than the other, yet both property types were distributed among individuals in both categories at the same proportion (e.g., 18:8 and 9:4). After learning about all 39 individuals participants were asked to attribute either the infrequent or frequent property to each individual. Participants attributed the infrequent behaviors to the rare group at higher rates (48%) than the common group (22%). Thus, participants formed an illusory correlation – they falsely perceived a relationship

between the rare property and the rare category even though no such relationship was presented in the evidence.

Illusory correlations are interesting because they violate normative models of categorization (Fiedler, 2000). That is, rather than utilizing the correlational structure of the data, people appear to rely on other, less optimal strategies in the course of categorization. Indeed, the phenomenon is related to other forms of base-rate neglect that have been demonstrated in the categorization literature (Kruschke, 1996; Medin & Edelson, 1988).

Several mechanisms have been proposed to describe why people form illusory correlations. One view is that illusory correlations are the product of memory processes such as having a stronger memory trace for the common elements in the task (Rothbart, 1981; see also Hintzman, 1986), or heightened memory for the distinct features of the evidence such as rare properties and categories (Hamilton & Gifford, 1976; Mullen & Johnson, 1990). It has also been argued that an illusory correlation is the result of attentional learning mechanisms (Sherman, Kruschke, Sherman, Percy, Petrocelli, & Conrey, 2009). For example, Kruschke (1996; 2003) argued that people fail to attend to base rates in the course of multiple-item categorization due to an attentional shift in the learning phase. From this perspective, a learner first focuses on learning about the common group and common property. After building a representation of the common category, a shift in attention to the rare category elicits the expectation that a different property will be associated with this different category.

One way to better understand the mechanisms underlying this phenomenon is to explore the origins of illusory correlations. Surprisingly few studies have examined illusory correlations in children and all of these studies have involved children older than 5 years of age. Primi and Agnoli (2002) tested 6- to 22-year-olds using social and nonsocial stimuli. In their study, participants learned about individuals from a common category ( $N = 14$ ) and individuals from a rare category ( $N = 7$ ) each of which was paired with infrequent and frequent properties at the same ratio (e.g., 5:2). After the learning phase 6-year-olds' attributions of the

infrequent properties were higher to the rare category (51%) than were attribution of infrequent properties to the common category (36%). Similarly, Johnston and Jacobs (2003) provided evidence that by 7 years of age children will form illusory correlations. No studies have examined the formation in children younger than 6 years of age.

The prevailing view is that children younger than 6 years of age will not form illusory correlations because they lack the capacity necessary to organize the available evidence (Johnston & Jacobs, 2003; Primi & Agnoli, 2002). That is, younger children may not be able to encode the exemplars in the evidence as representing different categories, or they may not be able to recognize that the properties are more or less frequent. From this perspective, the complex set of data represented in most illusory correlation tasks should lead to random responding in young children. The attention-shift account has not been explored in developmental studies, which is surprising given the abundance of literature showing that young children rely on attentional learning mechanisms to learn about novel stimuli in their environment (Hanania & Smith, 2009). If attentional learning mechanisms are responsible for the formation of illusory correlations, young children should form illusory correlations, provided cues in the available evidence draw their attention to the different categories and properties. The present experiments tested this hypothesis.

This paper describes two experiments with 3- and 5-year-olds in which we explored the possibility that certain cues in the evidence will elicit the formation of illusory correlations in young children. We examined these age groups based on documented age differences in executive function between 3 and 5 years (Hanania & Smith, 2009; Zelazo, 2006). For instance, when subjected to a rule switch in a sorting game (e.g., sorting based on shape rather than color), 5-year-olds, but not 3-year-olds, are able to change their sorting behavior based on the new rule (Zelazo, 2006). Thus, 5-year-olds are able to flexibly switch their attention from one task to another while younger children do not exhibit the same flexibility. We expect that this inability of younger children to persevere attention will dispose them to be unable to form illusory correlations.

The present experiments involved a modified version of the standard illusory correlation paradigm in which children learned about the properties of categories and then were asked to make property attributions based on the distributions of properties in the evidence. However, each of the experiments involved additional cues that were included to support the formation of illusory correlations. In Experiment 1 we included a differentiation phase prior to training in which children were provided cues to highlight that the task involved learning about two different kinds of animals. We

expected that this subtle cue would support category differentiation and thus might be sufficient to cause children to form illusory correlations. However, the results from Experiment 1 indicated this was not the case. Thus, Experiment 2 introduced more overt cues intended to elicit the formation of illusory correlations. In this case we presented the categories in such a way to support an attention-shift from one category to the other during training: In the training all of the individuals from the common category were presented first, followed by the presentation of the individuals from the rare category. We expected that this method of presentation would cause an attention-shift and therefore lead to the formation of illusory correlations. For both of the experiments we anticipated that we might observe age differences such that older children, but not younger children, would be more likely to form illusory correlations.

## Experiment 1

Participants learned about the properties of two different categories (e.g., dogs and bugs). The items were designed such that one category and one property were common and that the other category and property were rare. Moreover, both properties were distributed the same across both categories. The experiment included a differentiation phase that highlighted the two categories prior to training. We anticipated that this differentiation phase might help children recognize that the evidence included two categories and that doing so might support the formation of an illusory correlation. An alternative hypothesis is that highlighting the different categories may make it easier for children to identify the specific features associated with each of the categories. That is, telling children about the categories might cause them to pay less attention to category information in the training phase and instead focus on learning about the information for which they have no prior information (e.g., properties). It is possible that greater attention to the properties will support learning about the distributional features of the properties. Thus, in the attribution phase children may attribute the frequent and infrequent properties at the same rate across the two category types. Of course, it is also possible that children will be unable to encode all of this information and will simply respond at chance levels.

## Method

**Participants.** Seventeen 3-year-olds (10 males and 7 females) and eighteen 5-year-olds (9 males and 9 females) participated in this study and were recruited from local preschools. Participants were from diverse economic and racial backgrounds and were

representative of the city, and surrounding areas, of Philadelphia, Pennsylvania.

**Design and Materials.** The stimuli included two categories (dogs and bugs) represented by toy figurines (each approximately 1 inch in height or length). Participants were shown 8 figurines of one animal (common category) and 4 figurines of a different animal (rare category). The two properties were two different food (fruit) items that were represented by small toys located to the left or right of the child. Properties were manipulated within each category so that one property was more frequent than the other. A property ratio of 3:1 was equally distributed across both the common and rare categories. For example, for the common animal, 6 out of the 8 figurines had one property (e.g., ate the fruit on the left side of the child) and 2 out of the 8 figures had the other property (e.g., ate the fruit on the right side of the child), while 3 out of 4 figurines from the rare group also had the frequent property, and 1 out of 4 rare figurines had the infrequent property. The animals and properties were counterbalanced so that an approximately equal number of participants learned about each animal as rare or common and each property type as infrequent or frequent. Counterbalancing the location of the properties allowed us to track the possibility that children had a prior expectation about the fruit preference of dogs or bugs. The patterns of responses indicated children had no such preference.

There were three parts to the study: a differentiation phase, training phase, and attribution phase. The differentiation phase took place before the training phase and was designed to support differentiation between the two categories. The figurines of one category were spread out in front of the participant while the experimenter repeatedly (3 times) labeled the items (e.g., “Look, these are all dogs. Each of these animals is a dog. See all of these dogs?”). All of the items of the category were then removed and then the process was repeated for all of the items from the other category, after the experimenter described they were going to show a “different set of animals”.

In the training phase each of the 12 items was presented individually. The experimenter randomly presented one of the figurines to the participant and said, “This is a <label>. Watch this <label> eat. Yum. Yum. Yum.” While saying “yum yum yum,” the experimenter showed the figurine eating the fruit. This figurine was then placed in a pile and the experimenter presented the next figurine. The experimenter repeated this process for the remaining 11 figures. The experimenter then collected all the figurines.

The property attribution task was conducted immediately after the training session and involved the 12 figurines from the training set. The experimenter

randomly selected a figurine and showed it to the participant. The experimenter asked the participant to predict whether the animal eats the fruit from the left or right by saying “Here is a <label>. Show me where this <label> goes yum yum yum.” The experimenter repeated this process for all 12 figurines.

**Procedure.** Children were individually interviewed in a quiet location at their school. The experiment was presented as a “game” to elicit more enthusiasm over the course of the experiment. Also, children received a sticker after the completion of the experiment. The procedure lasted approximately 10 minutes.

## Results

Responses were averaged to yield mean attributions of frequent and infrequent properties for common and rare categories. Because the main analysis revealed no age differences, Figure 1 shows attributions collapsed across both age groups. The main analyses involved an Age (5-year-olds, 3-year-olds) x Category (common, rare) x Property (frequent, infrequent) ANOVA with the last two factors within-subjects. Note that the presence of an illusory correlation should lead to an interaction between property and category. However, the analysis yielded only a significant Property effect,  $F(1, 33) = 14.71, p = .001; \eta^2 = .31$ , due to a higher rate of attributions for the common category and the rare category for frequent properties ( $M = 0.61, SD = 0.25; M = 0.65, SD = 0.29$ , respectively) than infrequent properties ( $M = 0.39, SD = 0.25, M = 0.35, SD = 0.29$ , respectively). No significant Age differences were found, and the Property x Category interaction failed to reach significance,  $F(1, 33) = 0.33, p = .571$ .

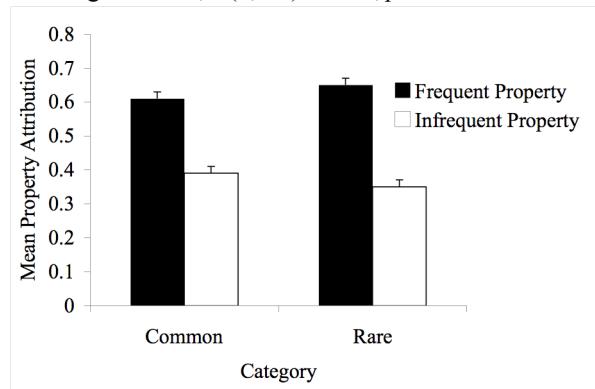


Figure 1: Mean property attributions of frequent and infrequent properties for common and rare categories. Error bars indicate one standard error from the mean.

## Discussion

Results from Experiment 1 indicate that 3- and 5-year-olds did not form an illusory correlation under these conditions. Instead, both groups of children generalized the frequent property more consistently than the

infrequent properties to both categories. One important conclusion from these results is that the absence of an illusory correlation in preschoolers is not due to an inability to encode the relevant information in the task. In fact, young children preformed quite well in the task, in the sense that their responses indicate that they accurately learned the correlational structure of the data. Thus, what remains unclear is why they did not form an illusory correlation from this evidence. One possibility is that the available cues in the evidence were not sufficient to draw children's attention to the different categories in the evidence. This possibility suggests that stronger cues designed to elicit attention to the two-category structure of the evidence should cause children to form illusory correlations. Experiment 2 was designed to test this prediction.

## Experiment 2

A second experiment was conducted in which we provided overt cues to elicit an attention-shift during the training phase. All facets of the experiment were the same as in Experiment 1, with one exception. In this case participants first learned about the properties of all of the individuals from the common category and then learned about the properties of all of the individuals from rare category. We expected that presenting information in this way would cause an attention-shift from the common category to the rare category and that this shift in attention would lead to the formation of an illusory correlation. Critically, we expect that children will associate the frequent property to the common property, and as a consequence of the attention shift, they will expect the other (infrequent) property is associated with the rare category. If, on the other hand, these young children are simply unable to form illusory correlations – perhaps because they are disposed to attend to the correlational structure of the evidence – then the results should replicate those found in Experiment 1.

## Method

**Participants.** Thirteen 3-year-olds (8 males and 5 females) and nine 5-year-olds (4 males and 5 females) that did not participate in Experiment 1 participated in Experiment 2 and were recruited from local preschools. Recruitment procedures were the same as in Experiment 1.

**Design, materials, and procedure.** The design was similar to the design used in Experiment 1; there was a differentiation phase, a training phase, and a projection phase. However, there was a blocked training such that all of the figurines of the common category were presented together first and then all the figurines from

the rare group were presented. In all other ways the design of Experiment 2 was identical to the design in Experiment 1.

## Results

Responses were calculated using the same method as Experiment 1. An Age (5-year-olds, 3-year-olds) x Category (common, rare) x Property (frequent, infrequent) mixed ANOVA revealed an effect of Property,  $F(1, 20) = 4.18, p = .05, \eta^2 = .17$ , due to higher attributions of the frequent properties ( $M = .57, SD = .12$ ) than infrequent properties ( $M = .43, SD = .12$ ). Critically, there was a Category x Property interaction,  $F(1, 20) = 12.25, p = .002, \eta^2 = .38$ , but no three-way interaction. Simple effects analyses revealed there was a higher rate of attributions of infrequent properties to the rare category ( $M = .55, SD = .25$ ) than to the common category ( $M = .31, SD = .18$ ), and a higher rate of attributions of frequent properties to the common category ( $M = .69, SD = .18$ ), than the rare category ( $M = .45, SD = .25$ ). Because there were no interactions with age, Figure 2 presents mean property attributions for all children combined.

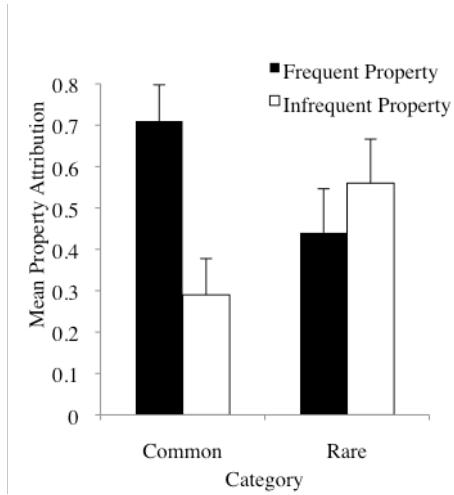


Figure 2: Mean property attribution of frequent and infrequent properties for common and rare categories. Error bars indicate one standard error from the mean.

## Discussion

These results indicate that presenting training items in a way that elicits an attention-shift between the two categories presented in the evidence caused young children to form an illusory correlation. The training effect had consistent effects for both age groups: 3- and 5-year-olds formed illusory correlations under these conditions. Thus, these are the first data to demonstrate the formation of illusory correlations in children 5 years of age and younger. These results indicate that children are not bound to categorize novel stimuli on the basis of the available correlational data – as in Experiment 1 –

but rather may be compelled to categorize based on perceived relationships between properties and categories.

## General Discussion

Two experiments examined the formation of illusory correlations in 3- and 5-year-olds. Experiment 1 provided evidence that these young children did not form illusory correlations, but rather generalized properties on the basis of the correlational data available in the evidence. However, the provision of overt cues that elicited an attention-shift from one category to the other category did lead to the formation of illusory correlations for both groups of preschoolers (Experiment 2). Overall, these are the first data to, 1) provide evidence that children younger than 6 years of age form illusory correlations, and 2) explore the conditions that are responsible for the formation of illusory correlations early in development.

Our interpretation of the findings is that they underscore the role of attentional learning in the process of categorization. Attentional learning has been explored in other research on cognitive development. For example, attention to cues in the environment is integral to early word learning (e.g., Smith, 1995) and rule-learning (e.g., Zelazo, 2006). Some research has examined the role of attention in categorization (Fisher, 2007 reviews this work), yet such research has focused on the role of attention in deriving accurate, or normative categorization decisions. One novel contribution of the present work is the demonstration that attentional learning mechanisms can lead to systematic and patterned biases in categorization in young children.

It is also possible that memory processes played a role in children's responses. The blocked presentation of the categories in Experiment 2 may have supported a stronger memory trace for the common elements of the evidence, or made the distinctive (i.e., rare) properties more salient. In general, we concede that other processes likely contribute to the formation and maintenance of illusory correlations. However, the results from Experiment 2 suggest cues that elicit a shift in attention from one category to another are necessary to elicit illusory correlations. It remains an important question for future research just which cognitive processes contribute to the formation of illusory correlations in children.

In regards to future questions, memory processes may be implicated in the formation of illusory correlations only under certain conditions. For example, people may be inclined to form illusory correlations when the sample of evidence is so large they are unable to recall the specific category-property associations. Thus, it is possible the absence of illusory correlations in

Experiment 1 was due, in part, to the small sample of evidence: Children may have been able to recall which properties were more frequent/infrequent and which categories were more common/rare. Given a larger training set (e.g., 24 exemplars), participants may be more susceptible to form illusory correlations because they are unable to recall specific features of the evidence. We are currently conducting a set of studies to test this possibility.

Another important question concerns the ecological validity of the illusory correlation. For example, in the normal course of the day an individual does not have access to all category members and the properties associated with these members. How strong (or real) is the disposition to form illusory correlations: Is evidence about only one member from a rare group performing an infrequent property sufficient to form an illusory correlation? Risen, Gilovich, and Dunning (2007) investigated this effect, the *one-shot illusory correlation*, in adults and found evidence to support this type of illusory correlation. We are currently examining the extent to which young children are inclined to form one-shot illusory correlations: Are children disposed to associate rare events when given minimal evidence?

A second question concerns racial categories in relation to stereotyping. Previous studies have investigated this effect with social stimuli (e.g., people performing good or bad behaviors). Findings suggest that illusory correlations do form with this type of stimuli (e.g., Hamilton & Gifford, 1976). While our study is the first to show that children as young as 5 years of age will form illusory correlations, we found this pattern for animal categories. Though we would expect to find the same pattern for social categories – such as race and gender – it is possible the present results are limited to the particular domain used in the present study. This possibility has broad implications concerning whether domain-general or domain-specific mechanisms are responsible for the formation of illusory correlations.

Given the erroneous and invasive nature of the illusory correlation, it is important to understand ways of eliminating such a potentially harmful type of reasoning. For example, a study conducted by Case, Fantino, and Goodie (1999) looked at the effects of base rate training or probability learning in the absence of cues in adults. Results indicate that the training significantly reduced base rate neglect. If this type of training can reduce base rate neglect in a particular task, it would be interesting to see what other types of training can reduce base rate neglect and in what other domains this training would be successful. More importantly, would this type of training be successful in children?

Even though questions remain concerning the mechanisms responsible for the illusory correlation

formation, the results from these two experiments support the conclusion that this phenomenon takes place earlier in development than has been previously indicated. Thus, one important conclusion from this study is that the type of irrational decision-making found in young children serves as a starting point for the irrational decision-making found in adults.

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