Research Report

WE SAW IT ALL ALONG: VISUAL HINDSIGHT BIAS IN CHILDREN AND ADULTS

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Abstract—We traced the developmental origins and trajectory of the hindsight bias. Three-, four-, and five-year-old children and adults identified gradually clarifying images of degraded common objects on a computer. Half the time, observers did not know in advance what the object would become. Other times, observers knew in advance the object's identity, and estimated when a naïve same-age peer would identify the clarifying object. In two experiments, children and adults demonstrated hindsight bias by using advance knowledge to overestimate their same-age peers' ability to identify the objects. The magnitude of this bias declined across age in one experiment, but remained relatively stable over age in the other experiment. This is the first demonstration of hindsight bias in children. These findings may have important implications for children's theory of mind.

When we try to estimate what another person or we would, should, or could have done in a particular situation, our judgment is often clouded by hindsight. Nearly three decades of research have established the existence of, and boundary conditions surrounding, hindsight bias in adults (e.g., Fischhoff, 1975; Hawkins & Hastie, 1990; Werth, Strack & Forster, 2002). Most of this work has used general knowledge questions, or problems with obscure solutions. The basic finding is that after obtaining information about the answer to a question, or the solution to a problem, people think that they "knew it all along." Thus, once we know something to be true, it is extremely difficult to ignore this information and reason about our own prior state or another person's "ignorance."

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Despite an abundant literature on hindsight bias, this effect has not yet been demonstrated in children. The reason for this is that traditional hindsight tasks rely on verbal methods and introspection well beyond the grasp of young children (e.g., "what would you have said if you hadn't known x?"). To circumvent this problem, we used a computer-based visual identification procedure recently developed by Harley and colleagues (Harley, Carlsen & Loftus, 2001; 2003). Although Harley et al. used this technique for adults, it is appropriate for children as it relies predominantly on visual perception rather than language. In our version of the task, observers—children, as well as adults—identified gradually clarifying common objects. On half the trials, observers had no advance knowledge of the object's identity, while on the remaining trials, observers knew a priori what the object was going to be, and their task was to estimate when a same age peer would identify it. The task and questions were identical for both children and adults: Observers were told that the same age peer had no advance knowledge of the clarifying objects' identity. Thus, our hindsight tasks resembled conceptual perspective taking tasks in that children and adults tried to determine a naïve peer's perspective (cf., Taylor, 1988). Our aim was to determine when hindsight bias develops and whether the magnitude of this bias changes with age.

EXPERIMENT 1

In Experiment 1, observers identified gradually clarifying images of degraded common objects. On half the trials, observers were naïve about the objects' identity (Baseline), whereas on other trials observers had foreknowledge, and their task was to estimate when a same age peer would identify the objects (Hindsight).

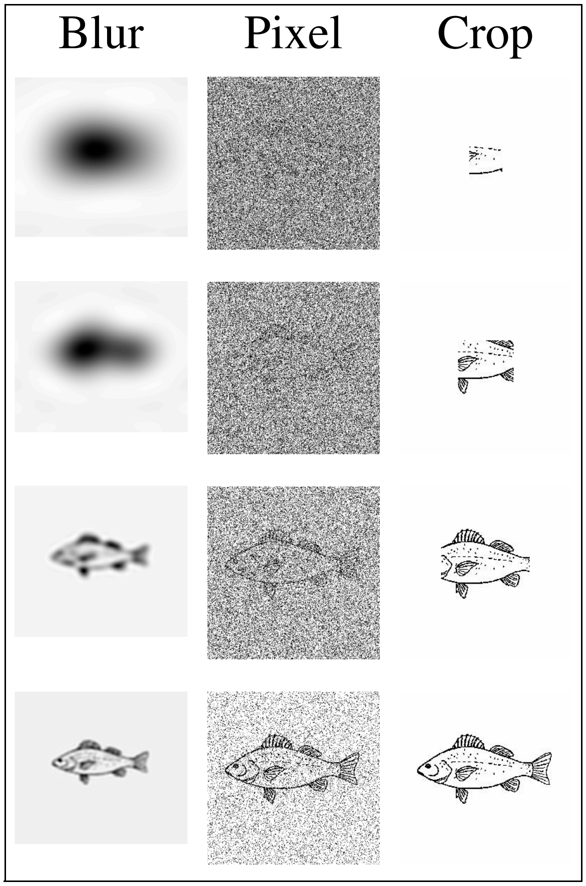

Fig. 1. Stimulus degradations. Experiment 1 included Blur and Pixel. Experiment 2 included Blur and Crop.

Method

Observers

Observers included 12 3-year-olds (Mean = 43.4 months, Range = 40-46; 7 female); 12 4-year-olds (Mean = 56.2 months, Range = 52-59; 7 female); 12 5-year-olds (Mean = 67 months, Range = 62-69; 8 female); and 16 University of Washington undergraduates (Adult: n = 16; 8 female).

Materials

Thirty-two line drawings of common objects (Snodgrass & Vanderwart, 1980) served as stimuli. Pictures of each object were scaled to fit a 245 X 245 pixel square on a G4 Macintosh laptop computer. Each object was degraded in two ways: Blur and Pixel (see Figure 1). Blurring was accomplished for each object by Fourier-transforming the object from pixel space into spatial-frequency space, multiplying the resulting frequency amplitude spectrum by a Gaussian low-pass filter and inverse-Fourier transforming the result back into pixel space. Degree of blur was determined by the size of the low-pass filter and, for technical reasons, is characterized as a distance (feet). For details, see Bernstein, Loftus & Meltzoff (2003) and Loftus (2001). For Pixel, some proportion of image pixels was changed to random grayscale values. Degree of Pixel degradation was characterized as the noise-to-signal ratio: p/(1-p) where p is proportion changed pixels.

For each object and each degradation type, we designed 15 increasingly degraded images such that differences between successive degraded images were roughly equal perceptually. Each object clarified from fully degraded to clear. Each of the 15 images per object remained on screen for 1000 ms., and then was replaced by the next, less degraded image[1].

Counterbalancing

Each trial involved observers identifying clarifying images of an object. The experimental session consisted of four blocks of eight trials per block. For a given block of trials, degradation type (i.e., Blur or Pixel), and outcome knowledge (i.e., Baseline or Hindsight) remained constant. The four experimental conditions were counterbalanced within each age group. A different object order was randomly generated for each set of four observers within each age group. The same object order was used for each of the four age groups.

Design

There were three independent variables: Age (3, 4, 5, Adult) X Degradation Type (Blur, Pixel) X Outcome Knowledge (Baseline, Hindsight). Degradation Type and Outcome Knowledge were within-subject factors whereas Age was a between-subject factor.

Procedure

Observers were tested, seated before a computer, either in their homes or in the laboratory. Observers received four practice trials, in which they identified images of common objects. The two Outcome Knowledge conditions (Baseline and Hindsight) involved different sets of objects. In the Baseline condition, each object was presented from most degraded to least degraded. Observers

[1] As part of another project, children completed three false belief tasks, but these data are not relevant to present concerns and will not be presented here.

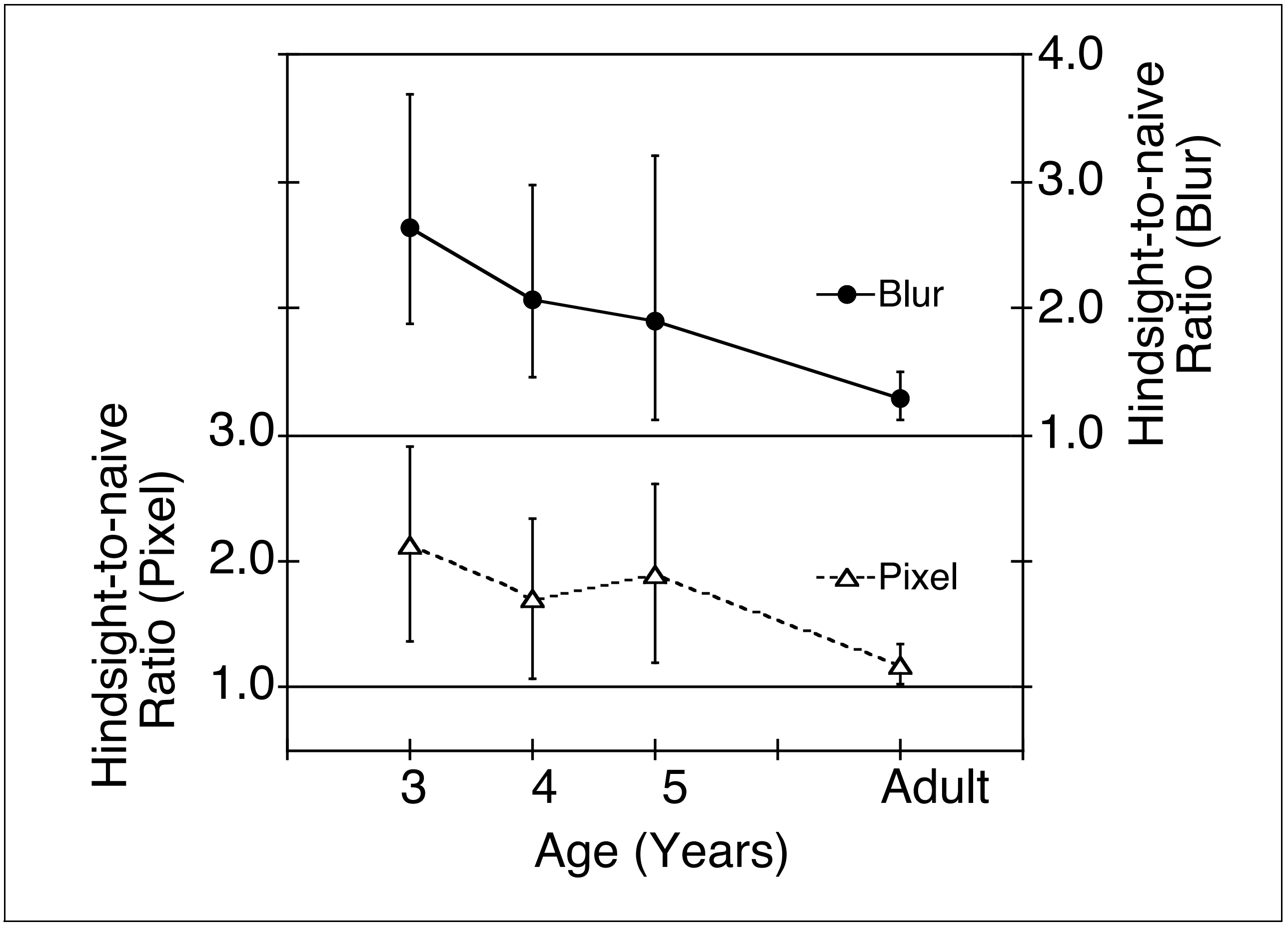

Fig. 2. Experiment 1 results. Error bars are 95% confidence intervals. The “Pixel” curve should be read against the left axis, while the “Blur” curve should be read against the right axis.

named the object aloud as soon as they identified it while it clarified. In the Hindsight condition, observers first saw the object in full clarity, and were asked, "What do you think it is?" After the child observers responded, they were told: "Ok, now it's Ernie's turn to play." For the children, we used an Ernie puppet from Sesame Street. Adults were simply told about a peer named Ernie. Both children and adults were told that Ernie was the same age as them, but that he had not seen the object or heard its name (Ernie wore felt earphones, and was taken out of a bag before being introduced to children). Child Observers were told: "You need to let me know exactly when Ernie sees the 'mouse' (current object). Say, 'mouse' as soon as Ernie first sees the mouse." The object then clarified just as it had in the Baseline condition. The experimenter (DMB) stopped the object clarification when children indicated that Ernie saw the object (e.g., "now he sees it" or "mouse"). The Experimenter then typed children's responses. Adult observers stopped the object and typed their own responses.

Results and Discussion

Child Observers identified over 96% of the objects. Only correctly identified objects were analyzed. Our main question was whether all four age groups demonstrated hindsight bias. We calculated hindsight bias for each degradation type as the ratio of the identification point in the Hindsight condition divided by that in the Baseline condition. These ratios appear in Figure 2[2]. Note that a ratio value greater than 1.0 indicates hindsight

[2] The data from one 4-year-old were not analyzed, because her Blur and Pixel hindsight values (5.5 and 14.9, respectively) were well above the values for the rest of her group.

bias, i.e., the observer identified the object at a more degraded level in the Hindsight condition than in the Baseline condition. All groups show hindsight: for no group did the 95% confidence interval include 1.0. Across the four groups, the average log hindsight effects are 1.91±0.22 and 1.69±0.19 for Blur and Pixel respectively[3]. Figure 2 shows that hindsight bias declined with age. We demonstrate this in two ways. First, we applied a contrast for monotonic decline to the four age groups (Weights = 6 1 -1 -6) to the log ratio for each degradation type. The magnitudes of this contrast were 1.89±1.17 and 1.49±1.30 for Blur and Pixel, respectively; i.e., neither confidence interval included zero. Second, we calculated the ratio of children-to-adult hindsight scores. These ratios were 1.69 (95% confidence interval 1.30 - 2.20) and 1.62 (95% confidence interval 1.23 - 2.13) for Blur and Pixel, respectively; i.e., neither confidence interval included 1.0.

These results indicate that (1) preschool children and adults exhibit hindsight bias by claiming that a naïve same age peer could identify images at a more degraded level than they themselves were able to identify similar images and (2) the magnitude of this bias declines from childhood to adulthood for both degradation types.

EXPERIMENT 2

The results of Experiment 1 indicate that children and adults are both susceptible to visual hindsight bias and that this bias declines with age. It is possible, however, that the observed hindsight bias resulted from using different objects in the Baseline and Hindsight conditions. Research in adults has shown that hindsight bias occurs whether individuals answer different questions (in our case, questions about different objects) in the Baseline and Hindsight conditions (as was done in Experiment 1) or the same set of questions twice. To test the generality of the visual hindsight bias, in Experiment 2 we presented the *same* objects for identification in the Baseline and Hindsight conditions. We also replaced the Pixel degradation with a Cropping degradation.

Method

Observers

Observers included 20 3-year-olds (Mean = 43.3 months, Range = 38-47; 13 female); 12 4-year-olds (Mean = 54 months, Range = 49-59; 6 female); and 12 5-year-olds (Mean = 66.75 months, Range = 62-79; 7 female), and one group of University of Washington undergraduates (Adult: n = 12; 8 female).

Materials and Counterbalancing

The materials and clarification process were similar to Experiment 1, with the following exceptions. There were 16 objects, each shown twice (once in the Baseline condition and once in the Hindsight condition). Instead of 15 images of each object, we designed 30 images. In the Crop condition, we cropped the object and then presented expanding portions of it, beginning in the middle, and expanding to the borders (see Figure 1). As with the Blur condition, we measured degree of Crop in terms of distance in feet (see Bernstein et al. 2003 for details). Unlike the continuous clarification procedure used in Experiment 1, images clarified as follows. Each image remained on screen for 600 ms., and was then replaced by the next, clearer one. After the 8th image was displayed, it remained on screen until the observer responded. Then, over the 21 remaining images, the image halted after every third image had been displayed. Thus, each trial consisted of eight stopping points in total over the 30 images of each object. Unlike Experiment 1, where the observer halted the image clarification to identify the object, this new clarification procedure permitted us to collect observers' responses at eight discrete points in time. Stimulus counterbalancing was done as in Experiment 1, except that a different object order was randomly generated for each set of two observers (instead of 4) within each age group. The same object order was used in both the Baseline and Hindsight conditions.

Design

The design was identical to Experiment 1.

Procedure

The procedure was similar to Experiment 1, except that the same object was shown in both the Baseline and Hindsight conditions. Therefore, observers first identified objects in the two Baseline conditions (Blur and Crop), and then estimated when Ernie identified the same objects as they clarified in the Hindsight conditions. Observers were not told about Ernie until they had completed the two Baseline conditions. For adults, the name of each object appeared onscreen prior to each trial

[3] In this article, when we state y±x, "x" refers to the 95% confidence interval.

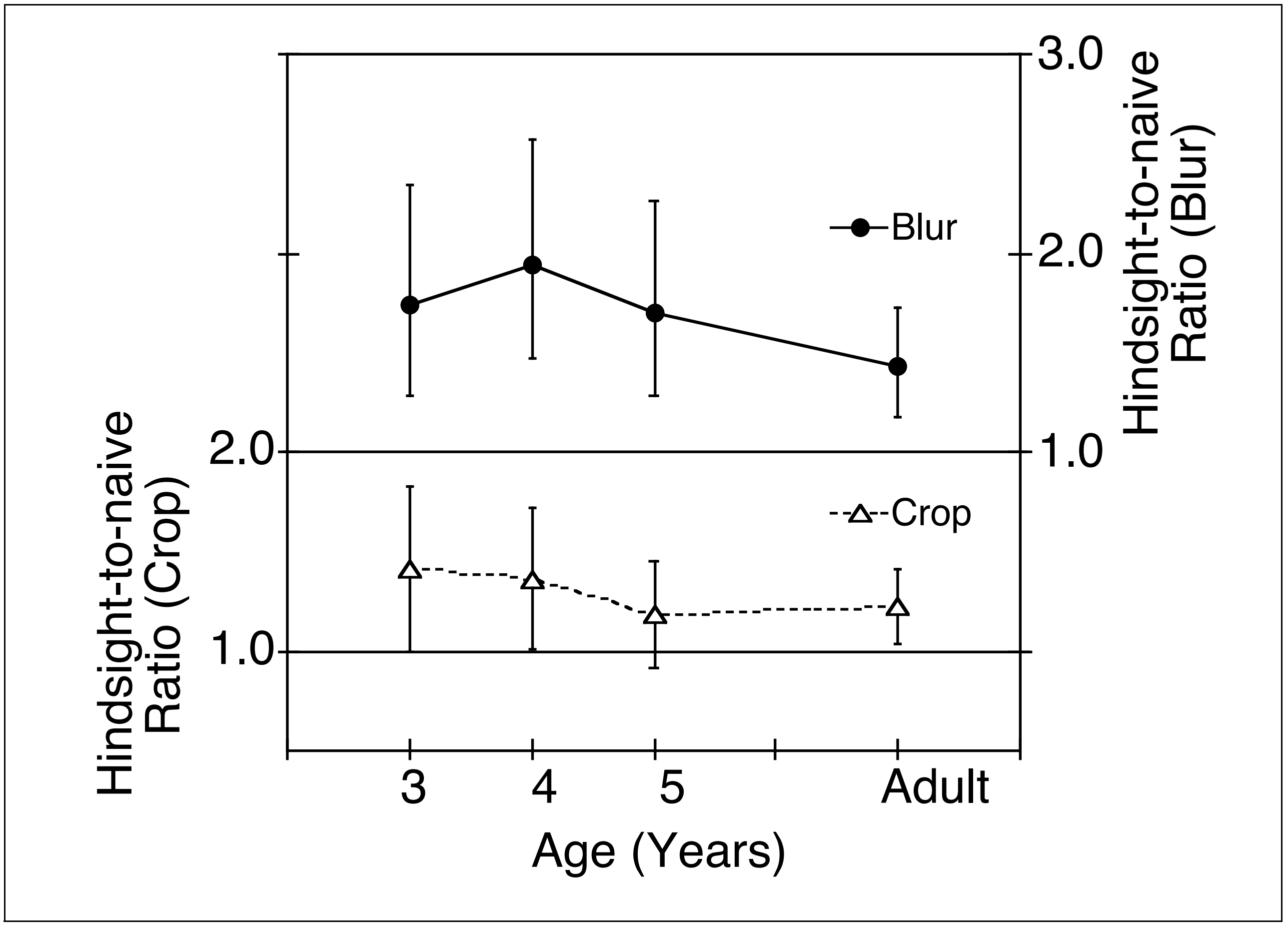

Fig. 3. Experiment 2 results. Error bars are 95% confidence intervals. The “Crop” curve should be read against the left axis, while the “Blur” curve should be read against the right axis.

in the Hindsight conditions. Children were told the object's name (e.g., "this is going to be the *fish*"). After each stopping point in the Baseline (and Hindsight) conditions, observers were asked: "what do you (does Ernie) see right now?" Children often responded to this question with answers like, "nothing," "not yet," or "show me more" before identifying the object.

Results and Discussion

Child Observers identified over 99% of the objects[4]. Only correctly identified objects were analyzed. We calculated hindsight bias as in Experiment 1, and the ratios are shown in Figure 3. The overall hindsight effect is less evident than it was in Experiment 1; however across the four groups hindsight emerged: the average hindsight effects are 1.70±0.25 and 1.32±0.17 for Blur and Crop, respectively. To determine whether the hindsight bias declined with age, we carried out analyses analogous to those in Experiment 1. The magnitudes of the monotonic-decrease contrast were 0.57±0.90 and 0.42±0.93 for Blur and Pixel, respectively; i.e., both confidence intervals included zero. The ratio of children-to-adult hindsight effects were 1.25 (95% confidence interval 1.10 - 1.42) and 1.10 (95% confidence interval 0.84 - 1.41) for Blur and Crop, respectively; i.e., only Blur excluded the null ratio of 1.0.

[4] The data from one 4-year-old and one 5-year-old were not analyzed, because their Blur and Crop hindsight values (0.72 and 0.45 for the 4-year-old and 0.21 and 0.34 for the 5-year-old) were well below the values for the rest of their respective groups.

In summary, the results of Experiment 2 replicate the main finding of Experiment 1: Children ages 3 to 5 and adults showed visual hindsight bias in a computer object identification task. Unlike Experiment 1, Experiment 2 did not yield clear evidence that hindsight bias declined with age.

General Discussion

In two experiments, preschoolers (3-, 4-, and 5-year-olds) and adults exhibited visual hindsight bias on the same object identification task. Our task was structured such that, half the time, observers did not know the object's identity a priori as it clarified (Baseline), while other times, observers knew the object's identity before estimating when a naïve, same age peer would identify the object (Hindsight). When observers knew the object's identity, they overestimated their peer's knowledge by claiming that their peer would identify the object before they themselves could. This visual hindsight bias occurred for two different types of visual degradation in each experiment and whether observers were tested on different objects (Experiment 1) or the same objects (Experiment 2) in the Baseline and Hindsight conditions. In sum, there was strong evidence that hindsight bias develops early in life and persists into adulthood (see Jacobs & Klaczynski, 2002). Hindsight bias declined with age in Experiment 1, but not in Experiment 2.

This is the first demonstration that hindsight bias exists in children. These findings may have implications for theory of mind development. Although both hindsight and theory of mind tasks, such as representational change (Gopnik & Astington, 1988), require children to reason about their own, or another's, state of ignorance, the substantial increase in performance that is well-documented in this, and other similar tasks, around age 4, is not mirrored by a concurrent decrease in the hindsight bias (see Birch & Bloom, 2001). These findings also may have more applied significance for both adult and child eyewitness testimony, where, in retrospect, observers believe that viewing conditions at the scene of a crime were better than they were. The present approach provides a valuable inter-disciplinary tool to study perception and cognition from both a developmental and cognitive science standpoint.

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