PRESCHOOLERS’ USE OF ABSTRACT INDIVIDUAL IDENTITY IN INDUCTIVE INFERENCE

by

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ABSTRACT

Children’s toys and books provide a rich arena for investigating conceptual flexibility, because they often can be understood to possess an individual identity at multiple levels of abstraction. For example, many toys (e.g., a stuffed Winnie-the-Pooh doll) can be construed either as characters from a fictional world, as physical objects in the real world, or as members of a kind. Similarly, books (e.g., a copy of The House at Pooh Corner) can be construed as instantiations of an abstract intellectual object, as individual physical objects, or as members of a kind.

In 4 experiments, 155 4- and 5-year-olds participated in a property extension task, the results of which provide evidence of a rich understanding of multiply instantiated individuals. In Experiment 1, children understood that two representations of a fictional character share certain properties in virtue of their shared character identity, and this sharing does not stem simply from having the same name. In Experiment 2, children demonstrated sensitivity to property origins in making inferences about multiple representations of a fictional character, extending properties from one representation of a character to another when the property was acquired by the character but not when it was acquired by the representation. In Experiment 3, children displayed the same conceptual flexibility and sensitivity to property origins when reasoning about multiple copies of an abstract intellectual object. In Experiment 4, children distinguished kind-based inductive inference from character-based inference, extending properties from one representation of a character to a representation of another character of the same kind when properties were inborn but extending properties only to another representation of the same character when they were acquired by the character.
In sum, the present findings revealed previously undocumented conceptual abilities in childhood. First, children use individual identity as well as kind identity as a basis for inferring shared properties. Second, children are sensitive to property origins, distinguishing properties that stem from an object’s identity as an instantiation of an abstract individual from those that stem from its discrete physical object identity and those that stem from its identity as an instance of a kind.
PREFACE

The ideas presented in this dissertation are the work of the author. They were developed through discussion and collaboration with her advisor, Dr. Geoffrey Hall. The author had primary responsibility for all aspects of all the research presented here.

Experiments 1 and 2 (expanded here), along with parts of the introduction and general discussion, appeared in the journal *Cognition* (reference: Rhemtulla, M., & Hall, D. G. (2009). Monkey business: Children’s use of character identity to infer shared properties. *Cognition, 113*, 167-176). This publication was the work of the author in collaboration with Dr. Hall.

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TABLE OF CONTENTS

ABSTRACT........................................................................................................................................... ii
PREFACE............................................................................................................................................... iv
TABLE OF CONTENTS .............................................................................................................................. v
LIST OF TABLES ....................................................................................................................................... vii
LIST OF FIGURES ................................................................................................................................... viii
ACKNOWLEDGMENTS .......................................................................................................................... ix
INTRODUCTION ....................................................................................................................................... 1
   Terminology ......................................................................................................................................... 4
   Background .......................................................................................................................................... 5
      Multiply Instantiated Abstract Individuals ......................................................................................... 6
      Conceptual Flexibility & Inductive Inference ................................................................................... 10
      Children’s Sensitivity to Property Origins ...................................................................................... 17
   Summary of Experiments ................................................................................................................... 19
EXPERIMENT 1 ....................................................................................................................................... 23
   Method .............................................................................................................................................. 23
      Participants ...................................................................................................................................... 23
      Materials ......................................................................................................................................... 23
      Procedure ....................................................................................................................................... 25
   Results .............................................................................................................................................. 29
      ANOVA Analysis ............................................................................................................................... 29
      Comparison to Chance .................................................................................................................... 30
      Nonparametric Analysis of Individual Response Patterns .................................................................. 31
   Discussion ......................................................................................................................................... 32
EXPERIMENT 2 ....................................................................................................................................... 33
   Method .............................................................................................................................................. 34
      Participants ...................................................................................................................................... 34
      Materials ......................................................................................................................................... 34
      Procedure ....................................................................................................................................... 35
      Practice Phase ................................................................................................................................. 35
      Storybook Phase .............................................................................................................................. 37
   Results .............................................................................................................................................. 40
      ANOVA Analysis ............................................................................................................................... 40
LIST OF TABLES

Table 1. Terminology.................................................................................................................. 5
Table 2. Target Properties Used in Experiment 1...................................................................... 24
Table 3. Target Properties Used in Experiment 2...................................................................... 38
Table 4. Target Properties Used in Experiment 3...................................................................... 51
Table 5. Target Properties Used in Experiment 4...................................................................... 67
LIST OF FIGURES

Figure 1. Experiment 1 Materials. ........................................................................................................... 26
Figure 2. Experiment 1 Results.................................................................................................................. 30
Figure 3. Experiment 1 Response Patterns ................................................................................................. 31
Figure 4. Experiment 2 Materials .............................................................................................................. 36
Figure 5. Experiment 2 Results.................................................................................................................. 41
Figure 6. Experiment 2 Response Patterns .................................................................................................. 43
Figure 7. Experiment 3 Materials. ............................................................................................................... 48
Figure 8. Experiment 3 Results................................................................................................................... 54
Figure 9. Experiment 3 Response Patterns .................................................................................................. 57
Figure 10. Experiment 4 Materials. ............................................................................................................ 64
Figure 11. Experiment 4 Results.................................................................................................................. 70
Figure 12. Experiment 4 Response Patterns ............................................................................................... 72
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INTRODUCTION

Any object—a chair, a computer, a dog, a person—can be construed as a unique individual, distinct from all other chairs, computers, dogs, or people. Perhaps the most obvious individuals in our lives are people and pets, who have unique personalities and traits. But these are not the only kinds of things that we construe as individuals, as suggested by our use of proper names for organizations (e.g., Greenpeace, the Supreme Court), businesses (e.g., Starbucks, Staples), places (e.g., Vancouver, Lake Erie), events (e.g., the Battle of Waterloo, Black Tuesday), transportation routes (e.g., the Oregon Trail, the Orient Express), diseases (e.g., Swine Flu, the Black Plague), brand models (e.g., Ikea Poang, Cheerios), fictional characters (e.g., Anne of Green Gables, Winnie-the-Pooh), and intellectual works (e.g., the Declaration of Independence, Jingle Bells). Many of the individuals in this list are abstract individuals, which, unlike people and pets, are not spatiotemporally continuous physical objects. In some cases, abstract individuals are not observable at all (e.g., Greenpeace, Black Tuesday). In other cases, they are observable in multiple instantiations of physical individuals—many trains, computers, copies of a book, or dolls can all be physical embodiments of a single abstract individual. These multiply instantiated abstract individuals are the subject of the present research.

Every time someone uses a mass-produced consumer product, reads or watches media, visits a chain store or restaurant, or listens to a piece of music, she is engaging with instantiations of an abstract individual. Children’s lives are no less full of these sorts of objects. From a very young age, children encounter and interact with toys, books, and frequently television shows. Children’s toys often represent fictional characters from popular children’s books, television shows, and movies. From Winnie-the-Pooh dolls to Lightning McQueen pull-back cars, children have daily experience with representations of fictional characters. Moreover, the books and
movies that contain these characters are themselves instantiations of abstract intellectual works. Children frequently have opportunities to encounter many copies of the same storybook or movie—at daycares, at friends’ houses, at doctors’ offices, and so on. Given their ubiquity, it is particularly striking that almost no research has investigated children’s understanding of multiply instantiated individuals.

Importantly, the set of objects that instantiate a particular abstract individual is a different kind of grouping than a taxonomic kind (e.g., statue or superhero). Instantiations of an individual can take many forms – for example, a Batman actor, a Batman doll, and a Batman illustration are all instantiations of Batman, but they are also very different kinds of thing (a person, a toy, and an artwork). For this reason, it is not right to say that instantiations of Batman are a kind of person, a kind of toy, or a kind of artwork. They are also not a kind of superhero, because another superhero could come along who had all of Batman’s traits (e.g., if Batman were cloned) and neither he, nor any representations of him, would be instantiations of Batman (though these would certainly be considered to be the same kind of superhero as Batman, having everything but individual identity in common with him). Similarly, Hamlet is not a kind of book, a kind of performance, or a kind of movie, because it can be instantiated in any of these forms and still be an instantiation of Hamlet. It is also not a kind of play, because there is a necessary intentional relation between the original intellectual object (Hamlet, as it was originally written) and copies, performances, and movies that instantiate it. A performance of any other play, no matter how similar in plot or speech, if it was not intended to be a performance of Hamlet, would not share Hamlet’s individual identity. Including both characters and intellectual objects, the only thing in common between all instantiations of an abstract individual is their relation to the abstract individual: each instantiation was created to be a copy, in some sense, of the original. This
feature of multiply instantiated individuals sets them apart from the object categories that have been the focus of research on children’s understanding of object kinds.

Almost all that we know about children’s understanding of individuals pertains to concrete, spatiotemporally distinct physical objects. A growing body of research on children’s understanding of individuals has concluded that from a very young age, children map proper names onto spatiotemporally distinct physical individuals, and track those individuals through space and time. Multiply instantiated abstract individuals need to be understood as spatiotemporally distinct physical individuals, but also as having a shared abstract individual identity. A Batman action figure, for example, has many idiosyncratic features (e.g., being made of plastic, having ketchup stains) that arise in virtue of its unique spatiotemporal history, but it also has many features that arise in virtue of sharing Batman’s character identity (e.g., wearing a mask, having big muscles). Similarly, a copy of Dr. Seuss’ The Cat in the Hat has unique properties that derive from the spatiotemporal history of the object (e.g., crayon scribbings on the pages, a waterproof cover), as well as having properties that derive from the book’s identity as a particular individual intellectual object (e.g., the story text and illustrations).

Multiply instantiated abstract individuals allow us to ask several new questions about young children’s concepts that have not yet been addressed. First, are children able to treat several instantiations of an abstract individual as having properties in common in virtue of their shared abstract identity? If so, do children have the conceptual flexibility to construe one physical instantiation as having both a unique spatiotemporal individual identity, in virtue of which it shares no properties with other objects, and a shared abstract individual identity, in virtue of which it shares properties with other instances of the same abstract individual? Finally, can children use shared abstract individual identity as a basis for learning new information by
drawing inductive inferences from one instantiation of an abstract individual to another? If they can, can they limit the scope of such an inductive inference to other instantiations of the same abstract individual rather than to other instances of the kind, when it is appropriate to do so? The present research investigates these questions in a series of four experiments.

**Terminology**

The experiments presented here deal with two kinds of multiply instantiated individuals: fictional characters (e.g., Winnie-the-Pooh) and intellectual objects (e.g., *The House at Pooh Corner*). For this reason, in addition to the fact that the present work deals with both abstract and concrete individual identity, it is worth taking a moment to introduce the terminology used throughout this dissertation. In the case of fictional characters, the physical instantiations of these individuals are more accurately described as *character representations*: Each Pooh doll and picture of Pooh in a book is a unique material entity that represents the abstract individual, Winnie-the-Pooh. Every character representation has *object properties* that stem from its identity as a physical object (its *object identity*); for example, a scratch on a Pooh toy’s plastic belly that arose when it fell on the floor is unique to the physical object. It also has *character properties* that stem from its identity as the character it represents (its *character identity*); for example, a Pooh toy may wear a red t-shirt because the character, Pooh, wears a red t-shirt in the stories by A. A. Milne. Finally, it has *kind properties* that stem from its membership in an abstract kind (its *kind identity*), for example, a Pooh toy’s bear paws stem from its membership in the kind, *bear*.

Copies of an individual intellectual work are somewhat different from character representations; a copy of *The House at Pooh Corner* is not a representation or a depiction of the original story; rather it is one of many equivalent physical embodiments of the abstract work. As
with character representations, copies of an intellectual work have an *object identity*, and corresponding *object properties* (e.g., crayon scribblings that a child drew on a storybook page). In contrast to character representations, the identity shared by several copies of an intellectual work is a *story identity*, and the corresponding properties are *story properties* (e.g., the artist’s illustrations on a storybook page). Like character representations, intellectual objects also have a *kind identity* and *kind properties*. Table 1 lays out this terminology with examples.

**Table 1. Terminology**

<table>
<thead>
<tr>
<th>Construal</th>
<th>Identity</th>
<th>Characteristic Properties</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Object</td>
<td>Object</td>
<td>A Pooh toy has a rip in its ear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Properties</td>
<td>A <em>House at Pooh Corner</em> book has a ripped page</td>
</tr>
<tr>
<td>Abstract</td>
<td>Character or Story</td>
<td>Character or Story Properties</td>
<td>A Pooh toy wears a red t-shirt</td>
</tr>
<tr>
<td>Individual</td>
<td>Identity</td>
<td>Story</td>
<td>A <em>House at Pooh Corner</em> book has an illustration of Piglet</td>
</tr>
<tr>
<td>Instance of Kind</td>
<td>Kind</td>
<td>Kind Properties</td>
<td>A Pooh toy has four bear paws</td>
</tr>
<tr>
<td>Kind</td>
<td>Identity</td>
<td></td>
<td>A <em>House at Pooh Corner</em> book contains a story</td>
</tr>
</tbody>
</table>

**Background**

Despite their ubiquity in children’s lives, we know almost nothing about children’s understanding of multiply instantiated abstract individuals. There is some research on related issues, however, which gives hints to underlying abilities that may allow children to reason in a sophisticated way about these kinds of objects. The following discussion begins with a review of research on children’s understanding of abstract individuals, before turning to the literatures on
children’s conceptual flexibility and inductive inference, and children’s sensitivity to property origins in the context of category membership and inductive inference.

**Multiply Instantiated Abstract Individuals**

In order to reason about two instantiations of an abstract individual (e.g., representations of a fictional character or copies of an intellectual object) as sharing an identity, children need to overcome their tendency to rely on spatiotemporal continuity when making judgments that pertain to individual identity. Existing research suggests that this tendency is strong. One line of research has revealed that children as young as 20 months of age will use an object’s spatiotemporal history, rather than its visible properties, as a basis for extending its proper name. At this age, children who hear a novel count noun for a doll or stuffed animal extend the word to new referents that look similar to the originally labelled object. Children who hear a novel proper name for the same doll or stuffed animal, however, continue to map the word exclusively onto the original referent, even after it undergoes a change in appearance and moves to another location. Children do not extend the name to another doll, even one that looks identical (e.g., Bélanger & Hall, 2006; Hall, Lee, & Bélanger, 2001; Katz, Baker, & Macnamara, 1974; Liittschwager & Markman, 1993; Sorrentino, 2001).

For example, Bélanger and Hall presented 16- and 20-month-olds with a familiar stuffed animal that was labelled with a novel word modelled syntactically as a either a proper name (e.g., “He is called Daxy”) or a count noun (e.g., “He is called a daxy”). Infants watched as the animal was moved to a new location, and a second, identical animal was presented in the original location. At test, children who learned a proper name were asked to “find Daxy” and children who learned a count noun were asked to “find a daxy”. Children’s initial looks to either object were measured. Children who heard the novel label presented as a proper name looked at the
original animal, despite the fact that the newer animal looked identical to it, and was in its original location. Children who heard the novel label presented as a count noun looked equally at both objects. These findings make clear that children as young as 20 months grasp the syntactic and semantic differences between proper names that refer to individuals, and count nouns that refer to kinds. For these children, individual identity, unlike kind identity, is strongly connected with spatiotemporal identity: children did not think that a proper name extended to a spatiotemporally discontinuous object that was perceptually identical to the originally labelled object.

By 20 months, children also infer the presence of multiple individuals from hearing two different proper names. Hall, Corrigall, Rhemtulla, Donegan, and Xu (2008) showed children one stuffed animal emerge twice from an opaque box. On each emergence, children heard a new label for the animal. Then the animal was taken out of the box and children were allowed to search the box for a second animal. Children who heard the two labels framed as proper names (e.g., “His name is Blick; His name is Fep”) searched significantly longer than children who heard one of the labels framed as a count noun (e.g., “He is a blick; his name is Fep”), showing that they believed a second individual remained in the box. Despite visual cues that were consistent with there being only one object in the box, children interpreted hearing two proper names to indicate that a second, spatiotemporally distinct object, was also present.

Another line of research has revealed that young children will often extend a proper name (or a unique identifying phrase) to an individual object that maintains a spatiotemporal path, even if it undergoes extensive changes in appearance, form, and/or material (e.g., Gutheil & Rosengren, 1996; Hall, 1998; Hall, Waxman, Brédart, & Nicolay, 2003; Liittschwager, 1995; see also Blok, Newman, & Rips, 2005, Rhemtulla & Hall, 2009; Rhemtulla & Xu, 2007; Rips, Blok,
& Newman, 2006). For example, Gutheil and Rosengren (1996) presented four- and five-year-olds with scenarios in which an animal (e.g., a dog) was described as having unique properties (e.g., will only eat food out of this red bowl). Children either heard that the animal’s name was changed, or that it underwent a change in appearance (e.g., a doctor changed it so that it looked like a different kind of dog). Children’s answers to a series of test questions revealed that they continued to identify the individual animal through transformations in both name and appearance. Similarly, Hall et al. (2003) showed three- and four-year-olds vignettes about characters who had descriptive proper names (e.g., Mr. Red, who was red) and who then underwent a change in appearance (e.g., fell into a bucket of green paint). Preschoolers’ responses suggested a belief that these characters continued to have the same individual identity (i.e., they kept their proper name), even though the descriptive adjective no longer applied.

Recently, Hood and Bloom (2007) showed that preschoolers treat some valuable artifacts as having greater worth than exact replicas, which are identical in everything but spatiotemporal history. Three- to six-year-olds were introduced to a cloning machine that produced an exact duplicate of items placed in the machine. When given the opportunity to clone one of their own possessions, children who had an attachment object (e.g., a special blanket or toy) chose to keep their original object (or flat-out refused to put it in the machine) rather than accept the clone. Children who were not attached to their toy, on the other hand, were excited to take the clone. In other words, when individual identity mattered, children chose the spatiotemporally continuous object. This finding suggests again that children’s concepts of unique individuals are strongly linked to spatiotemporal continuity.

Finally, in the sole study to use multiple character representations to study children’s concepts of individuals, Gutheil, Gelman, Klein, Michos, and Kelaita (2008) used character toys
(e.g., Winnie-the-Pooh dolls) to investigate four- and five-year-olds’ reliance on spatiotemporal history when inferring the knowledge state of individual objects. On one trial of their study, children were given a task (e.g., completing a puzzle) in one room, while one Pooh toy “watched”. Children “showed” the completed game to Pooh, and speculated about what Pooh thought of it. Children then moved to another room where an identical Pooh toy was present, and they completed a different task (e.g., a connect-the-dots drawing) with the second Pooh “watching”. After a similar “conversation” with the second Pooh, an experimenter entered the room with the original Pooh toy. Faced with the two Poohs, children were asked a series of questions about the knowledge state of each, pertaining to the tasks from each room. Children’s responses showed that they considered spatiotemporal history to be necessary for attributions of an individual’s knowledge state: Although Pooh 2 was physically identical to Pooh 1, children did not credit it with knowledge of the earlier events, nor did they credit Pooh 1 with knowledge of the later events. They did, however, credit each Pooh with knowledge of the events that it had “watched.”

Gutheil et al.’s (2008) study bears directly on the questions under investigation because it reveals that preschoolers are able to view two representations of the same fictional character as distinct individuals with distinct properties. However, the finding that children rely on spatiotemporal history when judging the knowledge states of individual objects suggests that it may be difficult for children to treat two representations of the same character as sharing an individual identity. In order to do so, children must overcome differences not only in the toys’ appearance but also in their spatiotemporal history.
Conceptual Flexibility & Inductive Inference

Multiply instantiated abstract individuals provide an opportunity to investigate children’s conceptual flexibility. The ability to construe an object according to many different concepts is central to even mundane tasks. When brushing one’s teeth, for example, it is necessary to construe one’s toothbrush as belonging to the kind, toothbrush (to avoid, say, using the razor) and as an individual – one’s own unique toothbrush (to avoid using someone else’s). Multiply instantiated abstract individuals add yet another layer of complexity to this task. For example, children engaging in pretend play with a set of toys from Finding Nemo may need to construe a particular toy as a member of a kind (e.g., fish) to know how to make it move; as a representation of a fictional character, (e.g., Nemo), to know how it talks; and as a particular physical object (e.g., the small plastic Nemo as opposed to the plush Nemo) to know whether it will float in the bathtub.

The ability to reason about two representations of a fictional character, or two instantiations of a book as both two (physical, concrete) individuals and one (abstract) individual may be a specific instance of a more general ability to reason flexibly about objects. While there is no evidence yet that children can reason about an object at two levels of individual identity, there is growing evidence that they can reason flexibly about an object at multiple levels of category identity. Inhelder and Piaget (1964)’s seminal experiments on children’s “multiplicative classification” found that preschool-aged children were unable to construe objects according to two different systems of classification. In one experiment, children were given 16 cards that depicted four subsets formed by crossing two categories (e.g., a set of people that varied along the dimensions male/female and old/young, or a set of rabbits that varied along the dimensions sitting/running and white/black). They were also given a box divided in four quadrants, and
instructed to sort the cards in various ways; for example, they were asked to sort the cards into two piles, then to sort again into two piles, “but differently”. While some older five-year-olds were sometimes able to sort the objects along both dimensions, this behaviour was rare. Moreover, Inhelder and Piaget noted that preschool-aged children were not able to justify their categorizations by appealing to more than one category at a time. They concluded that it was not until seven years that children were truly able to classify objects according to more than one category dimension.

A body of recent research, however, has presented children with drastically simpler versions of Inhelder and Piaget’s classification tasks, and has uncovered evidence that children far younger than seven are able to categorize an object as belonging to multiple different categories, like pet and dog, or breakfast food and dairy product (Blaye & Bonthoux, 2001; Deák & Maratsos, 1998; Deák, 2000; Hall, 1996; Nguyen, 2007; Nguyen & Murphy, 2003; Waxman & Hatch, 1992). For example, Waxman and Hatch (1992) showed that children as young as three spontaneously produce both basic-level (e.g., “dog”) and superordinate-level (e.g., “animal”) labels for the same object. Nguyen and Murphy (2003) presented three- and four-year-olds with a categorization task in which children were shown a target food (e.g., a watermelon) and two test objects (e.g., an orange, a fish), and asked to choose a match that was the same “kind of food” as the target. One of the test objects was unrelated to the target, and one shared either a taxonomic category (e.g., two fruits, such as watermelon and orange), a script category (e.g., two breakfast foods, such as waffle and egg), or an evaluative category (e.g., two junk foods, such as a Twinkie and Cheetos) with the target. Three-year-olds were able to successfully recognize both taxonomic and script categories, and four-year-olds successfully categorized according to all three types of relations.
Extending this finding, Nguyen (2007) found that children as young as two years old were able to identify both taxonomically related object pairs (e.g., pyjamas and sweater) and situationally related object pairs (e.g., pyjamas and blanket) as being “the same kind of thing.” By four years of age, children were able to simultaneously construe objects as belonging to both types of categories: when asked, for example, “Are pyjamas bedtime clothes?”, four-year-olds (but not younger children) attended to both parts of the object label when answering.

Deák and Maratsos (1998) revealed a similar ability in children as young as three. In their task, children saw representational objects (e.g., an eraser shaped like a dinosaur) and experimenters asked them, for example, “Is this a dinosaur and an eraser at the same time?” Children overwhelmingly agreed that objects could belong to one category in a literal capacity (e.g., eraser), as well as to another category in a representational capacity (e.g., dinosaur). This finding suggests that young children may have similar ease categorizing a character representation as, say, both a doll and Pooh.

The majority of research on children’s ability to construe an object as belonging to two or more categories (i.e., children’s “cross-classification” ability) has used simple categorization tasks to assess whether children are able to assign an object to two different categories. But categorization is not only useful for assigning objects to groups. Arguably the greatest benefit to categorization is its supporting role in inductive inference. Without inductive inference, knowing that a rambutan is a fruit would only be good for sorting it into the fruit basket rather than the bread box. With inductive inference, knowing that a rambutan is a fruit confers information about whether one is likely to enjoy eating it, whether it goes with ice cream, and so on. A large body of evidence has shown that, from a young age, children are adept at using information about category membership to draw inferences from one member of a category to others.
(Gelman, 1988, 2003; Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Keates & Graham, 2008; Welder & Graham, 2001). In a classic test of this ability, Gelman and Markman (1986, 1987) showed children triads of objects, including a pair of target objects that both looked different and belonged to different categories (e.g., a tropical fish and a dolphin) and a test object that looked similar to one target object but shared a label with the other (e.g., a shark that was labelled “fish” but looked like a dolphin). Children then learned a property of each of the target objects (e.g., the fish breathes under water, but the dolphin goes to the surface to breathe) and were asked which of these properties was true of the test object. Four-year-olds displayed a significant tendency to extend properties from the target object that shared a category label with the test object, despite differences in appearance.

It would be of little use to children to be able to assign an object to two categories if they could not also flexibly draw inferences to other members of each category. To continue the previous example, knowing that a rambutan is both a fruit and that it is tropical licenses the inferences that it will be sweet (like other fruit) and difficult to grow in Canada (like other tropical plants). For children to use their conceptual flexibility in the service of inductive inference, they must be able to distinguish the properties of an object on the basis of what categories they are likely to be associated with. There is evidence that adults draw these distinctions. Heit and Rubinstein (1994) found a small but significant tendency for adults to judge that objects belonging to the same category are more likely to share a property that is related to the category structure than one that is not. For example, participants rated a bear and a whale (two mammals) to be more likely to share an anatomical property (e.g., having a dual-chambered liver) than a behavioural property (e.g., travelling along a zigzag trajectory); the opposite pattern appeared when participants rated a tuna and a whale (two ocean-dwellers).
Recently, Sloutsky and his colleagues (Sloutsky, 2003; Sloutsky, Kloos, & Fisher, 2007; Sloutsky, Lo, & Fisher, 2001; Sloutsky & Fisher, 2004) have argued that inductive inference in children is based on similarity rather than on category membership. According to their “SINC” (Similarity, Induction, Categorization) model, children weigh attributes of an object (including its label and its perceptual features) to calculate its similarity to another object, and base their inductive inference and categorization behaviour on that similarity judgment. In support of their model, Sloutsky and Fisher (2004) reported a series of experiments in which four-year-olds participated in one of two tasks. Children in one group were asked to choose which of two test objects looked more like a target object, where one test object belonged to the same taxonomic category as the target and was given the same category label as the target, and the other test object belonged to a different taxonomic category but shared perceptual features with the target. An example of a triad was a plant-like coral (target), a different-looking coral, and a similar-looking plant. These similarity judgments were used to create an index of children’s perceived similarity between the target and each test item. A separate group of preschoolers participated in an inductive inference task involving the same object sets, where they learned contrasting properties of the two test objects and were asked to generalize one of the properties to the target object. Their results showed that similarity was highly predictive of children’s inductive inference behaviour: While there was an overall tendency for children to choose the test object that shared a label with the target object, the strength of this tendency was weaker as the similarity differential between the target and the two test objects (i.e., the difference between children’s perceived similarity of the target and perceptually similar test object and their perceived similarity of the target and the taxonomic match) increased.
Importantly, the SINC model suggests that children should not be able to flexibly draw an inference from a target object (e.g., a rambutan) to either of two objects that share different category memberships with the target (e.g., another fruit or another tropical plant) depending on circumstances (e.g., depending on the type of property). Sloutsky and Fisher (2004, p.185) argued that “knowledge of which cues are more central in particular contexts and knowledge domains” comes later in development.

There is some evidence, however, that even preschoolers exhibit flexibility in their inductive inferences (Gelman, 1988; Gelman & Markman, 1986; Kalish & Gelman, 1992; Nguyen & Murphy, 2003). Gelman (1988) found that four-year-olds made inductive inferences from one member of a basic-level kind (e.g., a rabbit) to another member of the same kind when the property in question was a broad, kind-referring property (e.g., “likes to eat alfalfa”). When the property was idiosyncratic (e.g., “is cold”), however, children did not generalize the property to other instances of the same kind. Gelman’s study provides preliminary evidence that young children can reason appropriately about an object either as a unique individual (e.g., as a particular rabbit) or as an instance of an object category (e.g., as a rabbit); moreover, they can differentiate properties that are likely to be true of an individual from those that are likely to be inferable to other kind members.

Gelman and Markman (1986) presented four-year-olds with object triads consisting of a target object (e.g., a shark) and a pair of test objects, one of which was perceptually dissimilar to the target but shared a taxonomic category with it (e.g., a tropical fish), and one of which was perceptually similar to the target but belonged to a different taxonomic category (e.g., a dolphin). Children learned a set of contrasting properties belonging to the two test objects; these properties were either taxonomically-based or perceptually-based. For example, a set of taxonomically-
based properties was, “This fish stays underwater to breathe; this dolphin pops above water to breathe.” Because mode of breathing is a biological property, it should be extended to other members of a taxonomic category. A set of perceptually-based properties was, “This fish weighs 20 pounds; this dolphin weighs 100 pounds.” Because weight is related to the perceptual property of size, it should be extended to other perceptually-similar (i.e., same size) objects. Children were asked which of the two contrasting properties applied to the target object. When properties were taxonomically-based, children tended to draw inferences according to shared taxonomic category; however, when the properties were perceptually-based, children showed no systematic pattern of inferences. These results suggest that, though children did not reliably draw inferences along perceptual category lines, they did distinguish between the two property types when inferring properties from one object to another.

Nguyen and Murphy (2003) presented four- and seven-year-olds with triads in which a target food (e.g., milk) was paired with a taxonomically-related food (e.g., butter) and a script-related food (e.g., a cookie). On each trial, children heard a novel property of the target food. These properties were either biochemical (e.g., “Pary is stuff inside milk.”) or situational (e.g., “Milk is eaten at a special time called Dax.”). Children were asked which of the two test objects was likely to share each property. Their results showed that seven-year-olds inferred that novel biochemical properties extended to another member of a taxonomic category, and situational properties extended to another member of a script category. Four-year-olds had an overall tendency to extend all properties to another member of a script category, but this tendency was significantly lower for biochemical properties. Nguyen and Murphy concluded, thus, that four-year-olds have some ability to selectively draw inferences across different kinds of categories.
Kalish and Gelman (1992) presented perhaps the strongest evidence of preschoolers’ inductive flexibility. Three- and four-year-olds saw object triads which included a target object (e.g., glass scissors), an object from the same object category (e.g., metal scissors) and an object from the same material category (e.g., a glass bottle). Children heard both a novel functional property of the target object (e.g., “used for partitioning”) and a novel dispositional property (e.g., “will get fractured if put in really cold water”). When asked which of the two test objects shared each property, four-year-olds successfully extended functional properties according to object category, and dispositional properties according to material category. These results suggest that four-year-olds are able to reason aptly about an object either as an instance of an object category or as a portion of a material category; moreover, they can associate novel functional properties with object categories, and dispositional properties with material categories.

Children’s Sensitivity to Property Origins

As noted earlier, children have some ability to narrow the range of inductive inference based on property type (e.g., idiosyncratic properties such as “is cold” vs. kind properties such as “eats alfalfa;” Gelman, 1988, Gelman & Markman, 1986). One cue that children may use to determine the scope of a property is the origin of the property, that is, how the property came to exist. For example, learning that Pooh was born with yellow fur may lead to the inference that yellow fur is a kind property, because kind properties tend to be present at birth. Learning that Pooh dyes his fur yellow, on the other hand, may lead to the inference that yellow fur is an idiosyncratic property of the character, because the property originated in the character’s own history. In the case of multiply instantiated individuals, property origins can be informative about both physical and abstract layers of identity. Learning that Pooh dyes his fur may lead to the inference that all Pooh toys (but not all toy bears) are yellow because the property originated in
the history of the character. On the other hand, learning that a Pooh toy was dyed yellow by its child owner may lead to the inference that yellow fur is an idiosyncratic property of the physical object (but not all Pooh toys), because the property originated in the unique history of the toy.

Recent findings from the developmental psychology literature have been mixed regarding children’s sensitivity to the origin of an object’s properties in their decisions about its category membership (e.g., Ahn, Gelman, Amsterlaw, Hohenstein & Kalish, 2000; Gelman & Bloom, 2007; Gelman & Kremer, 1991; Gelman & Wellman, 1991). On one hand, there is some evidence that older children moderate their inferences based on property origins. Ahn et al. (2000) presented seven- to nine-year-olds with a novel kind of animal that was said to have three internal properties, one of which caused the other two (e.g., “Pizers have blickem in their blood that causes them to have small lungs and purple skin”). Children then heard descriptions of two animals, one of which shared a causal property and an effect property with the target but lacked a second effect property (e.g., it had blickem and small lungs, but not purple skin), and one of which shared two effect properties but lacked the causal property (e.g., it had small lungs and purple skin, but no blickem). Children were asked which of the two animals was more likely to belong to the same kind as the target object (e.g., which one was a Pizer). Children were more likely to select the animal that was missing an effect property than one that was missing a causal property. Children in a control condition who heard the same three properties described in non-causal terms were equally likely to choose both animals. This finding suggests that older children can use information about property origins to determine whether a property is likely to indicate kind membership.

On the other hand, recent evidence from preschool-aged children suggests that young children may not be sensitive to property origins when making inductive inferences. Gelman and
Bloom (2007) asked five-year-olds and adults to reason about novel animal kinds (e.g., “dobles”) that had either acquired a property by natural internal causes (e.g., they grew claws) or acquired the same property by external causes (e.g., they put claws on themselves). When asked whether the property was true of the kind (e.g., “dodobles have claws?”), adults’ but not children’s responses differed according to the origin of the property. Whether the property origins were internal or external, preschoolers tended to endorse the generic statement (e.g., agreeing that “dobles have claws”). Adults, on the other hand, only endorsed the generic statement when the property origins were internal. Here, five-year-olds showed no sensitivity to property origins in making inferences from a few novel category members to the kind. In discussing their findings, Gelman and Bloom raised the possibility that their use of unfamiliar creatures may have placed excessive task demands on the children because they had to keep track of both novel kinds as well as information about property origins. If this was the case, their results may have underestimated children’s capacity to consider property origins when deciding whether to generalize a property from a group of individuals to a kind. For this reason, in the present experiments we began by using familiar kinds to explore children’s sensitivity to property origins in their inductive inferences.

Summary of Experiments

In a series of four experiments, we examined, 1) whether children are able to treat two spatiotemporally distinct representations of a fictional character as having a shared abstract identity, 2) whether children are able to use information about property origins to distinguish object properties from character properties, 3) whether children’s ability to reason aptly about multiple representations of a fictional character extends also to reasoning about multiple instantiations of an intellectual object, and 4) whether children’s sensitivity to property origins
allows them to distinguish character properties not only from object properties, but also from kind properties.

In Experiment 1, we asked whether preschoolers recognize the individual identity shared by two toys that look different but represent the same fictional character, and use this identity to infer that the toys share certain character properties. We tested children’s ability to use shared character identity in this way by comparing their property extensions in two conditions where a pair of toys had the same proper name: one where the shared name reflected the fact that the two toys represented the same fictional character, and one where the shared name arose by mere coincidence. Prior research in developmental psychology has documented the important role of a shared label in promoting inductive inferences across objects, but that work has also highlighted the importance of the word’s lexical form class in licensing such inferences (e.g., Gelman & Coley, 1990; Keates & Graham, 2008). Of particular note, Heyman and Gelman (2000) found that preschoolers were likely to judge that two dissimilar-looking people shared certain psychological properties if the people were labelled with the same trait adjective (e.g., “shy”) but not if they were labelled with the same proper name (e.g., “Anna”). Experiment 1 provided a test of whether preschoolers extend certain properties across objects that share a proper name, if the shared proper name reflects a shared character identity.

In Experiment 2, we further explored children’s understanding of the properties shared by representations of the same fictional character. We pitted properties that arose in virtue of one representation’s character history against those that arose in virtue of its unique spatiotemporal history, and we explored children’s willingness to generalize these properties to another representation of the character. If preschoolers show sensitivity to property origins when reasoning about representations of fictional characters, we predicted that they would restrict
properties arising from the representation’s unique spatiotemporal history but extend properties arising from the character’s history to another representation of the character. As reviewed earlier, several recent studies using inductive projection tasks have found evidence of conceptual flexibility in preschoolers (Gelman, 1988; Kalish and Gelman, 1992; Nguyen and Murphy 2003; Nguyen, 2007). Experiment 2 allowed us to test whether this conceptual flexibility extends to a flexibility in reasoning about *individuals* at two levels of abstraction.

In Experiments 1 and 2, we examined character toys because of their ubiquity among preschoolers, but they are not the only objects children encounter that possess an abstract individual identity in addition to their unique object identity. Experiment 3 examined abstract intellectual objects—books, magazines, comic books, and newspapers—that are instantiated in multiple physical copies. Like Experiment 2, Experiment 3 again explored children’s sensitivity to property origins in making inductive inferences from one instantiation of an individual to other instantiations of the same individual. We predicted that if children can use property origins to make accurate inductive inferences from one instantiation of an intellectual object to others, they would extend properties that were said to originate in the story to other copies of the same intellectual object. We predicted that they would not extend those properties that were said to originate in the unique history of the physical object. We further predicted that children in neither condition would extend the property to a distracter object that was a copy of a different intellectual work. Experiment 3 allowed us to explore whether the findings of Experiment 2 would generalize to a very different set of multiply instantiated abstract individuals.

In Experiment 4, we returned to toy representations of fictional characters, and presented children with a further test of their sensitivity to property origins. Children saw a representation of a novel fictional character belonging to a novel animal kind. Both the individual and the novel
kind were labelled (e.g., Debbie the doble). Children heard about a property that arose either in virtue of the representation’s character identity, or in virtue of the representation’s identity as a kind of creature. As noted earlier, there is evidence that preschoolers have difficulty deciding whether a property is true of a biological kind based on information about the property’s origins (Gelman & Bloom, 2007). In Experiment 4, we were interested in testing whether children’s capacity to consider property origins when making inductive inferences about multiple representations of an abstract individual could be extended to different individuals of the same kind.
EXPERIMENT 1

Method

Participants

Twenty-four children participated: 12 four-year-olds (mean age = 4;5; 8 girls) and 12 five-year-olds (mean age = 5;8; 6 girls). All were native English speakers. We focused on four-year-olds because prior research indicates that children of this age have the ability to reason flexibly about objects under multiple conceptual descriptions (e.g., Gelman, 1988; Kalish & Gelman, 1992; Nguyen & Murphy, 2003), and we included five-year-olds in order to assess any increase in this flexibility in a slightly older group. Equal numbers of each age group were randomly assigned to either the character-shared name (n = 12; 7 girls) or the accidentally-shared name (n = 12; 7 girls) condition. A further nine children participated but were excluded for failing the mapping test (n = 3), failing to answer at least three of the four filler questions correctly (n = 2), or because of experimenter error (n = 4).

Materials

We created two versions of an illustrated storybook, entitled “Boris and the Tiger’s Trap.” (See Appendix A for both versions of the text.) In the character-shared name condition, the story was the tale of a purple, freckled, toothless monkey, named Boris, who was rescued from a tiger by his two best monkey friends, named Igor and Fred. In the illustrations, Igor was depicted as similar in appearance to Boris (purple, freckled, and toothless); Fred was depicted as dissimilar in appearance to Boris (pink, unfreckled, and buck-toothed). In the accidentally-shared name condition, the story and illustrations were identical, with one exception. In the text,
Boris’ purple monkey friend was also named Boris, not Igor; in other words, two of the characters happened to share the same name.

Page two of the storybook contained a written description of each of four target properties belonging to Boris. See Table 2. On this page and on all other pages in the storybook, Boris was depicted facing forward, so that none of these properties were ever visible. We kept the properties out of sight in the storybook to encourage children in the property extension task (described next) to associate the properties of the target toy (a representation of the main character, Boris) with the character rather than with his illustrated representation.

Table 2. Target Properties Used in Experiment 1

<table>
<thead>
<tr>
<th>Property</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana on his ear</td>
<td>He got that when he was a baby</td>
</tr>
<tr>
<td>Pink heart on his back</td>
<td>He got that from his mother</td>
</tr>
<tr>
<td>Mark on his back</td>
<td>He got that when the tiger was chasing him</td>
</tr>
<tr>
<td>Dark patch on his bum</td>
<td>He got that from falling out of a tree</td>
</tr>
</tbody>
</table>

We also used three toys to represent the storybook characters. The target toy was a purple, freckled, toothless monkey that represented the main character, Boris. It was large, furry, and stuffed. This toy had on its back-side the four physical properties described in the previous paragraph. These properties could not be seen from the front. The distractor toy was a pink, unfreckled, buck-toothed monkey that represented Boris’ friend, Fred. Like the target toy, it was large, furry, and stuffed. The distracter toy thus matched the target toy in size, texture, and material. The name-match toy was another freckled, toothless, purple monkey. It was small (less
than half the size of the target), smooth, and made of hard modelling clay. The name-match toy thus matched the target toy in facial features and color. The name-match toy was described differently to children in the two conditions. In the character-shared name condition, it was said to be another representation of the main character, Boris. In the accidentally-shared name condition, it was said to be a representation of Boris’ friend, Boris. See Figure 1.

We also used three stuffed toys of familiar kinds—a bear, a dog, and a rabbit—for the practice phase.

**Procedure**

**Practice Phase.** The child sat at a small table across from the experimenter. The experimenter explained that they were going to play a game that had one rule: the child was allowed to point and look at the toys, but was not allowed to touch them. She placed the three familiar stuffed animals on the table: the bear and the dog beside each other on one side of the table, and the rabbit on the other side. The experimenter explained that she would ask the child some questions that would require pointing to either the bear or the dog. The experimenter asked, “Which one of these is a dog?” and “Which one of these is a bear?” For both these practice questions, the child was encouraged to point. He was praised for pointing correctly, and he was corrected for pointing to the wrong animal, pointing to both objects, or touching the toys. This set-up and these questions were meant to familiarize children with what they would encounter later in the test phase, and to give them experience in picking both objects that occupied the positions where the test objects would later appear.
Figure 1. Experiment 1 Materials.

**Character-shared name condition:**

TARGET: “Boris”

Distracter: “Fred”

Name-Match: “Boris”

**Accidentally-shared name condition:**

TARGET: “Boris”

Distracter: “Fred”

Name-Match: “Boris”

**Storybook Phase.** The experimenter brought out the version of “Boris and the Tiger’s Trap” appropriate for the condition and read it to the child, pointing out each character on every page of the book as she read. After hearing the story, the child was asked to recall the names of the three characters, making reference to each character’s illustrated representation on the front
The experimenter then said, “I was in a toy store the other day, and guess what I found! Look! I found Boris!” She presented the target toy and placed it on one side of the table. She then presented the name-match toy and placed it on the other side of the table. In the character-shared name condition, the experimenter declared, “Look what else I found! It’s another Boris! See, so this [target] is Boris, and this [name-match] is another Boris!” In the accidentally-shared name condition, she declared, “Look what else I found! It’s the other Boris! See, so this [target] is Boris, and this [name-match] is his friend Boris!” Finally, the experimenter brought out the distracter toy and placed it next to the name-match toy. The experimenter then said, “And I also found Fred!” The left-right placement of the name-match and distracter toys was counterbalanced between children.

In the accidentally-shared name condition, notice that each toy represented a different character from the story: the target toy was Boris (the main character); the name-match toy was Boris (Boris’ friend); and the distracter toy was Fred (Boris’ other friend). In the character-shared name condition, two of the toys represented the same character from the story: the target toy was Boris (the main character); the name-match toy was Boris (another representation of the main character); and the distracter toy was Fred (Boris’ other friend). To clarify for children in the character-shared name condition that there was no toy surrogate for the third character from the story, Igor, the experimenter made a brief comment, noting that she couldn’t find Igor in the toy store.
The experimenter asked the child to recall the names of the three toys on the table. If he could not, he was reminded of each toy’s name.

The experimenter then administered a mapping test to ensure that the child understood the connections between the toys and the story characters, as represented by their illustrations in the storybook. For each toy on the table, the experimenter asked the child to point to the representation of the corresponding character on the cover of the storybook. By passing this mapping test, children in the accidentally-shared name condition revealed a grasp of the one-to-one mapping between toys and characters and, in particular, that the two toys named “Boris” corresponded to different characters in the story. Children who passed this test in the character-shared name condition revealed an understanding of the two-to-one mapping between the Boris toys and the main character in the story. The three children who failed the mapping test were excluded from the experiment. The experimenter then removed the storybook from the table.

**Test Phase.** The experimenter asked four test questions, interspersed with four filler questions. The order of the four test questions and the order of the four filler questions were counterbalanced across participants within each condition. Before asking each test question, the experimenter picked up the target toy and showed the child one of the four hidden properties on its back-side. For example, the experimenter said, “Remember in my story, Boris had a banana on his ear. He got that when he was a baby. And look! This Boris has a banana on [the back-side of] his ear! See?” The experimenter then pointed to the two other test toys (the name-match and the distracter), looked at the child, and asked, “What about these two? Which one of these do you think has a banana on his ear? This Fred, or this Boris?” The order of mentioning the two options was counterbalanced between participants within each condition. The experimenter
continued to look only at the child’s face until the child pointed to one of the test toys. If the child expressed doubt, he was encouraged to guess.

The filler questions were similar to the test questions, but they queried properties that were clearly visible from the front of the toys. Two properties applied to the name-match (i.e., has freckles, is purple), and two applied to the distracter (i.e., has teeth, is pink). The two children who answered more than one filler question incorrectly were excluded from the experiment.

Results

We predicted more choices of the name-match toy in response to test questions in the character-shared name condition, where the name-match was another representation of the same character as the target, than in the accidentally-shared name condition, where it was a representation of a different character. In the accidentally-shared name condition, we expected random choosing between the toys, anticipating that the perceptual similarity between the target toy and the distracter toy (in size, texture, and material) would make the distracter toy a salient alternative to the name-match toy.

ANOVA Analysis

Children received a score out of 4 corresponding to the number of choices of the name-match toy they made in response to the test questions. The results were clear. Children in the character-shared name condition overwhelmingly extended the properties to the name-match toy ($M = 3.92, SD = .29$), while those in the accidentally-shared name condition did not ($M = 1.58, SD = 1.73$). To examine the effect of our manipulation as well as the effect of age on children’s choices, we conducted a 2 (age: four-years, five-years) by 2 (sex: male, female) by 2 (condition:
character-shared name, accidentally-shared name) fully between-subjects ANOVA. This analysis revealed a main effect of condition, $F(1, 16) = 19.19, p < .001, \eta^2_p = .55$, and no other significant effects or interactions.

**Figure 2. Experiment 1 Results**

![Figure 2. Experiment 1 Results](image)

**Comparison to Chance**

Two single-sample t-tests allowed us to compare the means of each condition to chance. If children had no systematic basis for making their toy choices, they should have chosen the name-match toy on 2 out of 4 trials, on average. Therefore, we predicted that the mean in the accidentally-shared name condition would not differ from 2, but that the mean in the character-shared name condition would be significantly higher than 2. We adjusted for multiple tests using a Šidák correction (i.e., by setting the critical $p$-value to $1-0.95^{1/n}$, where $n$ is the number of tests being performed; here, critical $p = .025$; Abdi, 2007). The mean in the accidentally-shared name condition did not differ from chance, $t(11) = -.83, p > .25, d = .24$, whereas the character-
*shared name* condition mean was significantly higher than chance, $t(11) = 23.00$, $p < .001$, $d = 6.62$. These results matched our predictions.

**Nonparametric Analysis of Individual Response Patterns**

Finally, non-parametric analyses allowed us to compare the numbers of children in each condition who showed a strong tendency to choose the name-match toy. Children were classified as name-match responders if they chose the name-match toy on at least 3 out of 4 test trials. By this criterion, all 12 of the children in the *character-shared name* condition were name-match responders. In the *accidentally-shared name* condition, just 4 children were name-match responders. See Figure 3. This difference is highly significant according to a chi-square test, $\chi^2(1, N = 24) = 12.00$, $p < .001$, $\phi = .71$.

**Figure 3.** Experiment 1 Response Patterns
Discussion

In Experiment 1, four- and five-year-olds who learned a character property belonging to a toy representation of a character tended to extend the property to another toy with the same name if the second toy was described as another representation of the same character. In contrast, children did not do so if the second toy was described as a representation of a different character who happened to share the same name. The results offer evidence that children as young as four years can look beyond a representational object’s unique spatiotemporal history to its abstract character identity to infer some of its properties.

Our finding that children did not extend the properties across objects that accidentally shared a proper name is consistent with the results of Heyman and Gelman (2000), who found that preschoolers did not expect two girls who happened to share a proper name to share psychological properties. In their study, children were shown a set of two girls who looked different. Children were taught a proper name for each girl, and a novel property of each of the girls (e.g., “This girl is Anna; she likes to play tibbits. This girl is Beth; she likes to play jimjam”). At test, children saw a third girl who looked similar to one of the pair, but shared a proper name with the other. Children showed no tendency to extend the preference property based on a shared proper name. Our discovery that children did generalize the properties across objects that shared a proper name when the objects represented the same character extends and qualifies those prior findings.
EXPERIMENT 2

Do children expect objects that share a character identity to share all the same properties? Clearly they do not. In Experiment 1, children appeared willing to accept that a large, furry, stuffed Boris toy and a small, smooth, clay Boris toy both represented the same character and shared character properties, despite their differing appearances. In Experiment 2, we examined whether children understand that two representations of a character should have only certain properties in common. As adults, we realize that properties possessed by a representation in virtue of the character it represents (e.g., a heart-shaped birthmark on a toy) should be shared by other representations of the same character. Properties possessed by a representation in virtue of its identity as a unique physical object (e.g., a heart-shaped stain on a toy) should not be shared. In Experiment 2, we investigated children’s understanding of this distinction.

The method of Experiment 2 differed from that of Experiment 1. In Experiment 2, we sought to manipulate whether the test properties under consideration pertained to the main character in the storybook or to one representation of the character. As a result, we could not present the properties as belonging to both an illustrated representation of the main character from the storybook and a toy representation of the character, as we did in Experiment 1. (Doing so would inform children that the properties generalized across representations of the character.) Instead, in Experiment 2 we showed children the test properties directly on one representation of the main character in the storybook, and we varied whether we described these properties as originating from the character’s history or from the representation’s (i.e., the physical storybook’s) history. We then asked children whether they thought the properties could be extended to either of two test toys, one representing the main character and one representing a different character from the story.
Method

Participants

Forty-eight children participated: 24 four-year-olds (mean age = 4;8; 14 girls) and 24 five-year-olds (mean age = 5;6; 14 girls). All were native English speakers. Equal numbers of each age group were randomly assigned to participate in either the character properties ($n = 24$; 15 girls) or the object properties ($n = 24$; 13 girls) condition. A further 21 children participated but were excluded for failing the mapping test ($n = 5$), failing to answer at least three of the four filler trials correctly ($n = 10$), touching the objects in an attempt to look for the hidden properties ($n = 2$), failing to point ($n = 1$), or due to experimenter error ($n = 3$).

Materials

We used a modified version of “Boris and the Tiger’s Trap” from the character-shared name condition of Experiment 1. Recall that the text on page two of that storybook described four properties pertaining to the main character, Boris, and this description was accompanied by an illustration of Boris facing forward. In Experiment 2, we altered this illustration so that Boris now faced away, making his back-side visible. Doing this allowed us to show the four properties directly on the representation of Boris on the page. We then created two versions of this altered storybook for use in the two conditions of the experiment. For the version used in the character properties condition, the text accompanying the illustration on page two was identical to the text in Experiment 1, involving a description of the four target properties, along with a statement of how the character came to possess them. For the version used in the object properties condition, we removed the text from the page. Doing so allowed the experimenter to present a description of the same four target properties as in the character properties condition, along with an explanation of how the representation (i.e., the illustration in the physical storybook) came to
possess them. In all other respects, the two versions of the storybook were identical to each other and to the one used in the character-shared name condition of Experiment 1.

We used the purple, large, furry, stuffed monkey from Experiment 1 as the character-match toy (representing the main character, Boris) and the pink, large, furry, stuffed monkey from Experiment 1 as the distracter toy (representing Boris’ friend, Fred). See Figure 4. In addition, we used a red stuffed bear and a pink stuffed dog for the practice phase.

**Procedure**

**Practice Phase.** The experimenter sat across from the child and explained the no-touching rule, as in Experiment 1. The experimenter then placed the red stuffed bear and the pink stuffed dog beside each other on the table, and asked the child four practice questions: “Is one of these a dog?” “Is one of these a fish?” “Is one of these red?” and “Is one of these green?” When the correct answer was “yes” (i.e., for two questions) the child was encouraged to say “yes” and point to the correct toy. When the correct answer was “no” (i.e., for two questions) the child was encouraged to say “no.” Children received praise for right answers and were corrected for mistakes. This set-up and these questions were meant to familiarize children with what they would encounter later in the test phase of the experiment; they were also intended to give children experience in answering both “yes” and “no” to questions.
Figure 4. Experiment 2 Materials

Character Properties Condition

Object Properties Condition

Target representation

Character-Match

Distracter

Distracter

Character-Match
**Storybook Phase.** The experimenter brought out the version of “Boris and the Tiger’s Trap” appropriate for the condition and read it to the child, pointing out each character on every page of the book as she read. In the *character properties* condition, the experimenter read the description of the properties as written on page two, pointing out each property on the back of the illustrated monkey on the page as she read. Each property was described as originating from the history of the character. For example, pointing to the banana on the back of the illustrated monkey’s ear, the experimenter read, “Boris had a banana on his ear that he got when he was a baby.” In the *object properties* condition, there was no text on page two. Instead, the experimenter described the same properties as in the *character properties* condition, also pointing out each property on the back of the illustrated monkey on the page as she spoke. Each property was described as originating from the history of the illustrated representation. For example, pointing to the banana on the back of the illustrated monkey’s ear, the experimenter said, “Boris has a banana on his ear; my friend drew that on my book.” See Table 3 for a full list of target properties and origins in the two conditions. As in Experiment 1, the child was then asked to recall the names of the three characters, making reference to each character’s illustrated representation on the front page of the storybook. If he could not do this, the experimenter reminded him of each character’s name.
Table 3. Target Properties Used in Experiment 2

<table>
<thead>
<tr>
<th>Property</th>
<th>Character Properties</th>
<th>Object Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Condition</td>
<td>Condition</td>
</tr>
<tr>
<td>Banana on his ear</td>
<td>He got that when he was a baby</td>
<td>My friend drew that on my book</td>
</tr>
<tr>
<td>Pink heart on his</td>
<td>He got that from his mother</td>
<td>My mom drew that on my book</td>
</tr>
<tr>
<td>back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark on his back</td>
<td>He got that when the tiger was chasing him</td>
<td>I accidentally drew that with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a marker on my book</td>
</tr>
<tr>
<td>Dark patch on his</td>
<td>He got that from falling out of a tree</td>
<td>I accidentally spilled some ink</td>
</tr>
<tr>
<td>bum</td>
<td></td>
<td>there on my book</td>
</tr>
</tbody>
</table>

As in Experiment 1, the experimenter then presented the two test toys, in a counterbalanced order, describing them as coming from the toy store, as in Experiment 1. The character-match toy was the large, furry, stuffed, purple monkey, introduced as the main character, Boris. The distracter toy was the large, furry, stuffed, pink monkey, introduced as Boris’ friend, Fred.

The experimenter then asked the child to recall the names of the two toys on the table. If he could not, he was reminded of each toy’s name.

As in Experiment 1, the experimenter administered a mapping test to ensure that the child understood the connections between the toys and the story characters. For both toys on the table, the experimenter asked the child to point to the representation of the corresponding character on the cover of the storybook. The five children who failed the mapping test were excluded from the experiment.
**Test Phase.** As in Experiment 1, the experimenter asked four test questions, interspersed with four filler questions. Again, the orders of the test and filler questions were counterbalanced across participants within each condition. The experimenter began by re-opening the storybook to page two. Before asking each test question, the experimenter reminded the child of one of the four properties shown on the back of the illustration of Boris. For example, in the character properties condition, the experimenter said, “In my book, Boris has a banana on his ear. Remember, he got that when he was a baby.” In the object properties condition, the experimenter said, “In my book, Boris has a banana on his ear. Remember, my friend drew that on my book.” The child was then asked whether he thought the property extended to one of the two test toys on the table. For example, the experimenter asked, “Do you think that one of these has a banana on his ear?” The experimenter looked only at the child’s face until the child answered. If the child expressed doubt, he was encouraged to guess. The child was free to answer “yes” or “no”; and if he answered, “yes,” the experimenter asked him to point to his choice.

As in Experiment 1, four filler questions queried properties visible from the front of the toys. Two of the properties applied to neither toy (i.e., is green, has a bellybutton), one applied to the character-match toy, Boris (i.e., has freckles), and one applied to the distracter toy, Fred (i.e., has teeth). The 10 children (five four-year-olds, eight boys) who answered more than one filler question incorrectly were excluded from the experiment. We speculate that the number of excluded children was higher in Experiment 2 (10/48) than in Experiment 1 (2/24) because the filler questions in Experiment 2 were more difficult. In Experiment 1, answering a forced-choice filler question correctly simply required children to look for a property on both objects and then point to the object that had that property; one of the objects always had the property. In Experiment 2, answering a yes-no filler question correctly required children to look for a
property on both objects and then answer “yes” if one of them had that property (two questions) and “no” if neither of them had it (two questions). Children who were distracted or inattentive could have given a wrong answer if they failed to search carefully for the property on both objects.

Results

For the test questions, we predicted more “yes” responses accompanied by choices of the character-match toy in the character properties condition, where the properties originated with the character, than in the object properties condition, where the properties originated with the illustrated representation of the character. In the object properties condition, we expected “no” responses.

ANOVA Analysis

Children received a score out of 4 corresponding to the number of test questions on which they both answered “yes” and selected the character-match toy. The results supported our prediction. Children in the character properties condition had an average score of 2.67 (SD = 1.74), while those in the object properties condition had an average score of 1.21 (SD = 1.64). See Figure 5. To examine the effects of condition and age, we conducted a 2 (age: four-years, five-years) by 2 (sex: male, female) by 2 (condition: character properties, object properties) between-subjects ANOVA. This analysis revealed a main effect of condition, $F (1, 40) = 10.91$, $p = .002$, $\eta_p^2 = .21$, and no other significant effects.
Comparisons to Chance

Two single-sample t-tests allowed us to compare performance in each condition to chance. For these tests, we used the mean numbers of test questions (out of 4) on which children answered “yes,” regardless of what object they subsequently chose. Doing so enabled us to use 2/4 (50%) as our index of chance responding, as children would have been expected to answer “yes” to half of the questions, on average, if they were simply guessing. We predicted above-chance responding in the character properties condition, and below-chance responding in the object properties condition. We used one-tailed t-tests, in accordance with our predictions, and adjusted for multiple tests using a Šidák correction (critical $p = .025$). The mean number of “yes” responses in the character properties condition was above 50%, but not significantly so, $t (23) = \ldots$
1.88, p = .04, d = .39; all these “yes” responses were accompanied by a choice of the character-match toy. In contrast, the mean number in the object properties condition was lower than 50%, but again did not reach significance, t (23) = -1.69, p = .05, d = .35; all but four of these “yes” responses were accompanied by a choice of the character-match toy. This latter result indicates that children had a nonsignificant tendency to answer “no” in the object properties condition.

Nonparametric Analysis of Individual Response Patterns

Finally, we conducted a chi-square test to compare the numbers of children in each condition who showed a strong tendency to answer “yes” and to choose the character-match toy, to those who showed an equally strong tendency to answer “no”. Children who answered “yes” and chose the character-match toy on at least 3 out of 4 test trials were classified as character responders. Those who answered “no” on at least 3 out of 4 trials were classified as object responders. This classification captured 43 out of 48 children; the remainder showed an inconsistent pattern of responding. Out of 24 children in the character properties condition, 16 were character responders and 7 were object responders. In the object properties condition, just 5 children were character responders and 15 were object responders. See Figure 6. This difference is highly significant according to a chi-square test, \( \chi^2 (1, N = 43) = 8.50, p = .004, \phi = .44. \)
Discussion

In Experiment 2, four- and five-year-olds who learned that a physical property shown on an illustrated representation of a character in a storybook arose from an incident in the character’s history tended to extend the property to a toy representation of the character. In contrast, children who learned that the same property arose from an incident in the history of the representation itself tended not to extend the property. Depending on its origin, children thus appeared to link the same physical property to different levels of individual identity (i.e., that of a fictional character or that of a unique representation). The findings indicate not only that young children can use a character’s identity as a basis for extending properties across representations of the character, but also that they are appropriately selective about which properties they will generalize. This result is all the more impressive in light of Gelman and Bloom’s (2007) finding that four- and five-year-olds are not sensitive to the distinction between intrinsic (e.g., is an
inborn property) and extrinsic (e.g., is acquired externally) properties when determining whether a property generalizes to all instances of a kind (i.e., is generic) or is restricted to a particular instance or instances of a kind (i.e., is idiosyncratic). We will return later to a discussion of possible reasons for the discrepancy between children’s success in the present tasks and their insensitivity to a similar cue in Gelman and Bloom’s task. These results furnish new support for the claim that children as young as four years are sensitive to the origin of an object’s properties in making decisions about their extendibility to other objects (e.g., Gelman, 1988; Kalish & Gelman, 1992; Nguyen & Murphy, 2003; see also Ahn et al., 2000; Gelman & Wellman, 1991).
EXPERIMENT 3

Experiments 1 and 2 investigated children’s understanding of the shared identity among multiple representations of fictional characters. In those experiments, we focused on fictional characters and children’s toys because of the high level of familiarity that children have with these objects. But character representations are just one of many sorts of objects that have both a physical individual identity and an abstract individual identity that can be shared by many objects. Prasada (2010) has argued that intellectual objects, such as books, albums, and movies are the prime example of this two-layered identity. Like toys that represent fictional characters, copies of a book also share an abstract identity – multiple copies of a book can be said to be the same book (e.g., “Sam looked at Jane’s desk and saw that she was reading the same book he was”). In virtue of this shared identity, two copies of an intellectual object share properties that stem from the abstract individual (e.g., plot details and illustrations). Also like character representations, copies of a book have unique spatiotemporal histories, and as such, unique physical identities. As such, multiple copies of a book can be said to be different books (e.g., “Sam thought Jane stole his Wuthering Heights until he noticed the scratch on the cover and realized they were different books”). In virtue of these unique physical identities, two copies of an intellectual object have unique properties (e.g., dog-eared pages, publication year, or an autograph).

The shared abstract identity of intellectual objects is even more fundamental than that of character representations. While each of two Batman dolls can be said to “be Batman”, more accurately, they both represent Batman—their identity is shared in virtue of representing the same individual. As a representation, a Batman toy inherits some of the central features of the character, but it cannot share all of Batman’s features—only those features of a human character
that can be instantiated in plastic. Batman’s personality, his abilities, and his knowledge cannot be replicated in any toy, statue, or painting. While an actor may come closest to truly instantiating Batman, even he cannot fully inherit Batman’s identity. Intellectual objects, on the other hand, can really be said to fully share an identity at an abstract level. Every copy of *Wuthering Heights* (provided it is not missing pages) contains the whole identity of the intellectual work. As such, if all but one copy of *Wuthering Heights* were destroyed, the abstract individual would remain intact. In this sense, intellectual objects are a truer example of objects that have two clearly distinct individual identities at different levels of abstraction.

Even though most preschoolers are pre-literate, most of the reading material that they regularly encounter includes illustrations that do not require reading to understand. We used this feature of storybooks, comic books, magazines, and newspapers to investigate children’s understanding of the dual-layered individual identity of intellectual objects. Most children growing up in North America have some experience with some of these objects, from having parents or teachers that read to them, and having books to play with. As in Experiment 2, Experiment 3 again examined children’s sensitivity to property origins with a task in which children heard a novel property of an object that originated in the object’s unique spatiotemporal history (e.g., “I drew that on my book”) or in the history of the intellectual object (e.g., “that’s part of the story”). Children were asked whether the property extended to an identical object, a different-sized copy of the same story, and a copy of a different story. We predicted that if children are able to construe intellectual works in terms of both their physical and abstract individual identities, as they can do with character representations, then they should tend to restrict object properties of intellectual works to a single object, but extend abstract story properties to all copies of the same intellectual work.
Method

Participants

As in previous studies, we focussed on four- and five-year-olds. Fifty-one children participated: 26 four-year-olds (mean age = 4;4; 13 girls) and 25 five-year-olds (mean age = 5;5; 14 girls). All were native English speakers. Children were randomly assigned to either the object properties \((n = 23; 13 \text{ girls})\) or the story properties \((n = 28; 14 \text{ girls})\) condition. No children were excluded.

Materials

We modified four sets of purchased media objects: story books, comic books, magazines, and newspapers. Each set consisted of a target object, an identical copy (the story-match-identical object), a copy of the same intellectual work in a different size (the story-match-contrast object), and a copy of a different intellectual work (the distracter object). Each target object had the experimenter’s name written on the front cover, and a target property that was drawn somewhere on one of the inner pages. We chose each property to look like it could plausibly be either an original part of the published work, or a drawing added post-publication.

The storybook set consisted of three copies of the children’s story, *Thomas’ Snowsuit* by Robert Munsch. The target and story-match-identical storybooks were soft cover, and 9 cm by 9 cm. The story-match-contrast storybook was a larger, 20 cm by 20 cm version of the book, with the same cover illustration. The distracter storybook was a 9 cm by 9 cm soft cover copy of *Red is Best* by Cathy Stinson. See Figure 7. The target property was a red mitten that was part of the original illustration on the book, which we coloured over with red marker.
<table>
<thead>
<tr>
<th>Target Copy with Property</th>
<th>Story-Match-Identical</th>
<th>Story-Match-Contrast</th>
<th>Distracter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>
The newspaper set consisted of three copies of the newspaper, *Metro*. The target and story-match-identical copies were 29 cm by 38 cm on newsprint. The story-match-contrast copy was a smaller copy of the newspaper, made by shrinking the cover image of the target newspaper and printing it on 28 cm by 21 cm paper, mounting that cover onto another newspaper and cutting it to size. The distracter was a 28 cm by 41 cm *Georgia Straight* newspaper. The target property was a red heart drawn adjacent to an article.

The comic book set consisted of three copies of the comic book, *Fantastic Four*. The target and story-match-identical copies were soft cover, and 17 cm by 26 cm. The story-match-contrast copy was a smaller, 8.5 cm by 13 cm version of the comic book, made by scanning the target copy shrinking the image, and printing it onto heavy photo paper. This cover was mounted onto a magazine and cut to size. The distracter was a 17 cm by 26 cm soft cover copy of *Sonic Adventures*. The target property was a black star drawn on a comic panel that contained an image of the sky.

Finally, the magazine set consisted of three copies of the children’s magazine, *KNOW: The Science Magazine for Curious Kids*. The target and story-match-identical copies were soft cover, and 20 cm by 28 cm. The story-match-contrast copy was a smaller, 10 cm by 14 cm copy of the magazine, made in the manner described above. The distracter was a 20 cm by 28 cm soft cover copy of *Highlights* magazine. The target property was a balloon that was part of a puzzle in the magazine, which we coloured over with blue marker.

In addition, we used three stuffed animals in practice trials: a spotted dog, a pink cat, and a brown dog.
Procedure

**Practice Phase.** The child sat across a table from the experimenter. After the child agreed not to touch any of the objects, the experimenter placed the three practice animals in a row on the table. The experimenter explained that she would ask questions, and the child could answer “yes” or “no.” The experimenter began with the object on her left and moved to the right, asking one practice question while pointing to each animal in turn, then asking the second practice question while pointing to each animal in the same order. The two practice questions were, “Is this a dog?” and, “Is this green?” The order of the two questions was counterbalanced across children, and the animals were placed on the table in one of two orders: dog, cat, dog, or dog, dog, cat. We intended these two orders to mimic the order of the test objects during the test trials (i.e., story-match-identical, story-match-contrast, distracter, or story-match-identical, distracter, story-match-contrast). The correct answers to each practice question corresponded to our predicted pattern of responses for each condition (i.e., two yesses and one no for the *story properties* condition, and three nos for the *object properties* condition). In other words, by correctly answering both practice questions, each child showed that he was able to give the predicted pattern of yesses and nos for both conditions. All children successfully answered all practice questions.

**Object Presentation.** The experimenter presented the target object of the first object set. She introduced the object by saying, for example, “I want to show you my favourite storybook. It’s called, *Thomas’ Snowsuit* by Robert Munsch. I’ve read it lots of times. And look, I wrote my name on it here, because it belongs to me.” This last detail was added to reinforce the experimenter’s ownership of and familiarity with the target object, and to set it apart from the test objects, which were described as being borrowed and unfamiliar. This feature of the design
was analogous to Experiments 1 and 2, where the storybooks were said to be owned by and familiar to the experimenter, and the test objects were said to be newly purchased from the toy store. The experimenter then introduced the target property by opening the object to the relevant page and saying, for example, “Look, here on page 4, there’s a mitten.” She then explained to the child the origin of the property. In the story properties condition, she explained that the property was part of the story, for example, “That’s there because it belongs to the little boy in the story.” In the object properties condition, she explained that she herself drew the property on the object, for example, “That’s there because I drew it there with my red marker.” Table 4 displays the property origins for each property according to condition.

Table 4. Target Properties Used in Experiment 3

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Origin</th>
<th>Property Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitten on page 4</td>
<td>In the storybook story, the red</td>
<td>I drew it there with my red</td>
</tr>
<tr>
<td></td>
<td>mitten belongs to the little boy</td>
<td>marker.</td>
</tr>
<tr>
<td>Heart on page 5</td>
<td>A red heart is part of the story</td>
<td>I drew a heart in this space with</td>
</tr>
<tr>
<td></td>
<td>in the newspaper</td>
<td>a red marker.</td>
</tr>
<tr>
<td>Balloon on page 14</td>
<td>A blue balloon is part of the</td>
<td>I drew it there with my blue</td>
</tr>
<tr>
<td></td>
<td>story in the magazine</td>
<td>marker.</td>
</tr>
<tr>
<td>Star on page 22</td>
<td>In the comic book story, there's</td>
<td>I drew it with a black pen.</td>
</tr>
<tr>
<td></td>
<td>a black star in the sky</td>
<td></td>
</tr>
</tbody>
</table>

The experimenter then moved the target object to her left (keeping it on the table within the child’s view), and said, “Now look closely, I want to show you some other [books/comic books/magazines/newspapers] that are brand new.” She then presented the three test objects, one
at a time. The story-match-identical object was always presented first, followed by the story-match-contrast and distracter objects in counterbalanced order across trials. When presenting each test object, the experimenter read its title to the child, saying, for example, “This one is also called, ‘Thomas’ Snowsuit’.” or, “This one is called, ‘Red is Best’.” Finally, the experimenter gestured to all three test objects, saying, “These ones don’t belong to me. I borrowed them.”

**Test Phase.** Once all the test objects were on the table in front of the child, the experimenter pointed to the target object and reminded the child of the target property and its origin, for example, “Remember the mitten on page 4 of this storybook? Remember, that’s there because [in the storybook story, the red mitten belongs to the little boy / I drew it there with my red marker].” Beginning with the story-match-identical test object, she then pointed to each test object in turn, asking the child if he thought that it also had the same property, for example, “Do you think that this storybook has a red mitten on page 4?” If the child indicated that he was unsure, he was encouraged to guess. All children gave an answer to all test questions. The experimenter recorded the child’s answers, then put away the objects and began the object presentation phase anew with the next set of objects. The order of object sets was counterbalanced across children.

**Results**

We predicted that if children were able to use information about property origins to assign a property to the target object *qua* physical object or *qua* abstract individual, children in the *object properties* condition would be unlikely to extend the property to any of the test objects, whereas children in the *story properties* condition would tend to extend the property to the two copies of the same book/comic book/magazine/newspaper, but not to the distracter object.
(which shared kind membership, but not an individual identity, with the target object). We found that both four- and five-year-olds’ responses confirmed this prediction.

**ANOVA Analysis**

Children received a score from 0 to 4 for each type of test object, corresponding to the number of trials on which the child responded “yes” to the test question for that object. Children in the *object properties* condition tended to answer “no” to all test objects (story-match-identical test object, $M = 1.04$, $SD = 1.64$; story-match-contrast test object, $M = 1.00$, $SD = .34$; distracter test object, $M = .30$, $SD = .76$), consistent with a belief that the properties were unique to the target object. Children in the *story properties* condition tended to extend the properties to the two test copies that instantiated the same story, comic book, magazine, or newspaper as the target (story-match-identical test object, $M = 2.50$, $SD = 1.62$; story-match-contrast test object, $M = 2.86$, $SD = 1.60$), but not to the distracter object ($M = .25$, $SD = .84$). See Figure 8.
To investigate the effects of condition and age on children’s responses, the data were subjected to a mixed ANOVA with condition (2 levels: object properties, story properties), age group (2 levels: four-year-olds, five-year-olds), and sex (2 levels: male, female) as between-subjects factors and test object (3 levels: story-match-identical, story-match-contrast, distracter) as a within-subjects factor. This analysis revealed a main effect of condition, $F (1, 43) = 10.48, p < .005, \eta^2_p = .20$, a significant main effect of test object, $F (1, 53) = 46.81, p < .001, \eta^2_p = .52$, as well as the predicted interaction between test object and condition, $F (1, 53) = 13.96, p < .001, \eta^2_p = .25$. No other effects were significant. The degrees of freedom for the within-subjects effects were corrected due to a violation of the sphericity assumption.

Breaking the test object-by-condition interaction down into simple main effects of condition for each test object revealed a significant main effect of condition for the story-match-
identical test object, $F(1, 43) = 6.23, p = .017, \eta^2_p = .17$, and for the story-match-contrast test object, $F(1, 43) = 10.13, p = .003, \eta^2_p = .25$, but no effect of condition for the distracter object, $F(1, 43) = .01, p = .93, \eta^2_p = .001$. These results support the prediction that children in the story properties condition would have a greater tendency to generalize to the story-match-identical and story-match-contrast objects than children in the object properties condition. Children in both conditions tended not to extend the properties to the distracter object, indicating that they were not indiscriminate in their property extensions.

**Comparisons to Chance**

To evaluate children’s responses on a more absolute scale, we compared each mean to chance (i.e., 2/4 “yes” responses). We performed six directional t-tests, according to the predictions that children in the object properties condition would say “no” to every object (i.e., score below chance) and children in the story properties condition would say “yes” to the story-match-identical and size-contrast objects (i.e., score above chance), and “no” to the story-match-contrast object. We used one-tailed t-tests, in accordance with our predictions, and adjusted for multiple tests using a Šidák correction (critical $p = .0085$). This analysis found that, in both conditions, the distracter object mean was significantly below chance (object properties condition: $t(22) = -10.63, p < .001, d = 2.26$; character-properties condition: $t(27) = -10.97, p < .001, d = 2.11$). In the object properties condition, the story-match-identical and story-match-contrast means were significantly below chance (story-match-identical: $t(22) = -2.80, p = .005, d = .60$; story-match-contrast: $t(22) = -2.90, p = .004, d = .62$). In the story properties condition, the story-match-identical and story-match-contrast means were both above chance, but only the story-match-contrast was significantly so (story-match-identical: $t(27) = 1.63, p = .06, d = .31$; story-match-contrast: $t(25) = 2.83, p = .005, d = .54$).
Nonparametric Analysis of Individual Response Patterns

We conducted non-parametric analyses to examine individual children’s response patterns. Children were classified as object responders if they answered “no” to each of the test objects on at least 3 out of 4 trials. Children were classified as story responders if they answered “yes” to the story-match-identical and size-contrast test objects and “no” to the distracter object on at least 3 out of 4 trials. This classification captured 42 out of 51 children. Of the remaining children, 2 showed a tendency to extend the property to all three test objects (including the distracter) on 3 out of 4 trials, and the remainder did not show any consistent pattern. In the story properties condition, 15 were story responders and 6 were object responders. In the object properties condition, 4 were story responders and 17 were object responders. See Figure 9. A chi-square test on these proportions was highly significant, $\chi^2 (1, N = 42) = 11.63, p < .001$, $\varphi = .53$, indicating that the predicted relationships between condition and children’s response patterns were significant.
Figure 9. Experiment 3 Response Patterns

**Discussion**

Experiment 3 replicated Experiment 2’s finding that preschoolers can use information about a property’s origins to predict the range of that property’s extension. Children extended a property of a copy of an intellectual object to other copies of the same work (both an identical copy and a different-sized copy) when the property was described as being part of the story, but not when it was described as being drawn on the copy by the experimenter. In neither case did children show a tendency to extend the property to a copy of a different story: Only 2 children, one in the *story properties* condition and one in the *object properties* condition, consistently extended the property to the distracter object, consistent with a kind property interpretation.

As noted earlier, there are a wide variety of multiply instantiated objects that children encounter on a regular basis, including toys and books, but also stores and restaurants and all branded products. Considering the ubiquity of these objects, it is important to establish that
children’s ability to engage in sophisticated reasoning about the properties of multiply instantiated individuals goes beyond representations of fictional characters. In Experiment 3, children showed that their ability to reason about multiple instantiations of an abstract individual extends to copies of abstract intellectual objects such as books, magazines, comic books, and newspapers.

This experiment revealed that although children are able to generalize idiosyncratic properties across instantiations of an abstract individual, they are also able to restrict these generalizations from other instances of the same kind. This finding is important because it suggests that children do not promiscuously extend all generalizable properties across all instances of a kind. Of course, there are some properties of instantiations of an abstract individual that should generalize to all kind members. Experiment 4 examines these kind-relevant properties in more detail.
EXPERIMENT 4

The results of Experiments 1-3 suggest that young children have the capacity to flexibly construe an object as having both a material individual identity (object identity) and an abstract individual identity. This is the first evidence that children can use shared individual identity as the basis for inductive inference. One question that arises from this finding is how individual identity differs from kind identity as the basis for inductive inference. For example, do children understand that certain properties of a Pooh toy (e.g., his quizzical expression) should generalize only to other representations of Pooh, whereas other properties (e.g., the shape of his ears) should generalize not only to other representations of Pooh, but also to representations of other bears? A large literature on children’s inductive inference behaviour suggests that kind-based inference comes early for children (e.g., Gelman, 1988; Gelman & Markman, 1986, 1987). In Experiment 4, we were interesting in determining whether children distinguish shared kind identity from shared abstract individual identity as a basis for inductive inference. That is, can children use shared kind identity to infer kind properties across representations of characters belonging to the same kind, and use shared individual identity to infer character properties across representations of the same character.

Experiments 2 and 3 uncovered strong evidence that preschoolers can use property origins to distinguish properties that belong to an abstract individual identity from those that belong to a concrete physical identity. Children use this information successfully to inform their inductive inferences about what other objects should share a given property. Given children’s success in these experiments, we were interested in pressing further to investigate whether children could also use these skills to identify properties that originate in an object’s kind identity. As noted earlier, previous research has found that preschoolers are insensitive to the
distinction between properties that a creature is “born with” versus those that a creature “puts
on” (Gelman & Bloom, 2007). Gelman and Bloom’s finding that children tended to generalize
properties with an external origin (e.g., claws that were “put on”) at as high a rate as properties
with an internal origin (e.g., claws that were inborn) suggests that children may have a tendency
to over-extend character properties to all members of a kind. In contrast, in Experiment 2,
children almost never extended character properties to another monkey that represented a
different character. In Experiment 3, again, children did not extend story properties from one
copy of an intellectual work to a copy of a different intellectual work. However, the properties
that we used in those studies were the sort of idiosyncratic properties that are unlikely to be true
of all members of a kind, regardless of their origin (e.g., having a banana tattoo on one’s ear, or
having an illustration of a mitten on page 4). It is possible that, given more typically kind-
relevant properties, like the ones that Gelman and Bloom used (e.g., having claws), children may
ignore property origins in favour of extending the properties to all kind members. We thus
designed Experiment 4 to test whether the sensitivity to property origins that appeared in our
earlier experiments could extend to typically kind-relevant properties.

Experiment 4 returned to the storybook-and-toys design of Experiments 1 and 2. We used
unfamiliar creatures so that children would not have pre-existing knowledge about properties
belonging to the kind. Each novel kind had target properties that could be construed as kind-
relevant: wings, a horn, a stripe, and a tail. Each property was either described as being present at
birth (kind properties) or as being added during the character’s history (character properties).

We predicted that, if children’s success in Experiments 2 and 3 was due to their attending
to information about the property origin, then children hearing character-relevant (i.e., “put on”)
properties should extend the property to another representation of the same character, as they did
in those experiments, but not to a representation of another character of the same kind, and not to a distracter of a different kind. If children are further sensitive to the cue that a property that a creature is “born with” is relevant to kind membership, then children who hear kind properties should extend those properties to all creatures of the same kind, including both another representation of the same character and a representation of another character of the same kind, but not to a distracter of a different kind.

**Method**

**Participants**

Thirty-two five-year-olds were randomly assigned to one of two conditions: *character properties* \((n = 16;\text{ mean age } = 5;6; 10 \text{ girls})\), or *kind properties* \((n = 16;\text{ mean age } = 5;6; 7 \text{ girls})\). All were native English speakers. We focussed on five-year-olds in this study because we found no difference between four- and five-year-olds in previous studies. In addition, based on Gelman and Bloom’s (2007) finding that children of this age were insensitive to property origins when unfamiliar objects were used, we expected that this task might be more difficult for children than previous experiments involving familiar objects. One child participated but was excluded for failing the practice trial.

**Materials**

We created two storybooks to introduce the novel characters to children. The first was entitled, “The Dobles Play Outside” and was about Debbie, a spherical furry white creature with gold antennae and button-eyes called a doble. Debbie (the *target*) was pictured on the cover of the storybook with her two friends, who remained nameless. One of her friends (the *kind-match*) was also a doble; this creature looked identical to Debbie but had silver antennae and googly
eyes. Debbie’s other friend (the *distracter*) was a different kind of novel creature; it was a blue tube-shaped creature with six legs and Styrofoam eyes. Pages inside the book were filled with nonsense text (children did not see these pages), except for one page on which two target properties appeared. The illustration on this page showed Debbie’s back, and two target properties: a pink fuzzy tail, and blue wings.

The second storybook was entitled, “Super-fargle-licious” and was about Felix, a conical, hairy, purple creature with green pompoms and pink teeth called a fargle. Felix (the *target*) was pictured on the cover of the storybook with his two nameless friends, one of whom was also a fargle (the *kind-match*; with orange pom-poms, and red teeth), and the other of whom was a furry, green and cubical with white horns (the *distracter*). One page in the book displayed an image of Felix’s back with two target properties: a sparkly blue stripe, and a purple horn.

We created a set of three test objects to accompany each book: one (the character-match toy) represented the target character (i.e., Debbie or Felix), one (the kind-match toy) represented the kind-match (i.e., the other doble or fargle) and the last (the distracter toy) represented the distracter. See Figure 10.

We also used three stuffed toys of familiar kinds—a brown stuffed dog, a pink hard plastic dog, and a pink stuffed pig—for the practice phase.

**Procedure**

**Practice Phase.** The child sat at a small table across from the experimenter. The experimenter explained that they were going to play a game that had one rule: the child was allowed to point and look at the toys, but was not allowed to touch them. She placed the three practice toys front of the child, with the stuffed dog to the child’s right, one of the other objects
in the center, and the other to the child’s left. The placement of the hard dog and stuffed pig was
counterbalanced across children. The placement of these three objects was designed to
foreshadow the order of objects in the test phase, where the character-match toy was always
placed to the child’s right, and the placement of the same-kind and distracter toys was
counterbalanced.
Figure 10. Experiment 4 Materials.

Stimulus Set 1:

Character-Match: “Debbie”

Character-Match: “Felix”

Stimulus Set 2:

Kind-Match

Distracter

Kind-Match

Distracter
The experimenter explained that she would ask the child some questions that required a “yes” or “no” answer and asked the child to listen carefully. For each of three practice questions, the experimenter first pointed at the object on the child’s right, then center, then left, repeating the same question: “Is this brown?,” “Is this soft?,” and “Is this green?” The order of the practice questions was counterbalanced across children. Each question was designed to elicit a different pattern of responses: “Is this brown?” required the child to say “yes” to the stuffed dog, and “no” to the other two objects (consistent with how children would be expected to respond to the test questions if they interpreted the property as pertaining to the character, i.e., akin to predicted responding in the character properties condition). “Is this soft?” required the child to say “yes” to the stuffed dog and the stuffed pig, but “no” to the hard dog (consistent with how children would be expected to respond to the test questions if they interpreted the property as pertaining to the kind, i.e., akin to predicted responding in the kind properties condition). Finally, “Is this green?” required the child to say “no” to all three objects, consistent with how children would be expected to respond to the test questions if they interpreted the property as being unique to the target representation. While this last pattern was not a predicted pattern of responding in either condition of this experiment, it nonetheless reflected a legitimate interpretation of the test properties. If, as in Gutheil et al. (2008), children have a strong tendency to view multiple representations of a character as unique individuals that do not share properties, we might expect children to interpret character properties as being unique to a particular character representation. Including the “green” question in the practice trials enabled us to assess children’s tendency to restrict character and kind properties to the target representation.

Children were praised for answering correctly. If they answered incorrectly, the experimenter corrected the child and repeated the question once. If the child persisted in
answering incorrectly, the child was excluded from the study. One child was excluded for this reason.

In Experiments 1-3, children in one condition were predicted either to respond at chance (Experiment 1) or to produce only “no” responses (Experiments 2 and 3). In Experiment 4, predicted responses in both conditions involved a mixture of “yes” and “no” answers. This element of the design ensured that children who behaved as predicted could not have been responding according to a “no” bias in either condition.

**Storybook Phase and Object Presentation.** The experimenter presented the child with the two storybooks in counterbalanced order. For each storybook, the experimenter introduced the characters, for example, “I want to show you this storybook. Do you know what a doble is? This is a doble! Can you say ‘doble’? Right! This is a storybook about a doble named Debbie. See, here’s Debbie here [pointing to Debbie on the book cover]. And look, here are Debbie’s friends: this one [pointing to the kind-match on the book cover] is also a doble, and this one [pointing to the distracter on the book cover] is not a doble. So remember, Debbie [pointing] is a doble, and this friend [pointing] is also a doble, and this friend [pointing] is not a doble.” The experimenter asked the child to point at the target character and corrected the child if he pointed at the wrong character. All children pointed at the correct character.

The experimenter then introduced the toys by saying, “You know what? The other day I was in a toy store, and I found some toys. Look what I found!” She then presented the character-match toy first, followed by the kind-match toy and distracter toy in counterbalanced order. As she presented each toy, the experimenter introduced the toy (e.g., “This is Debbie’s friend from the story. She’s also a doble.”) and asked the child to point to the corresponding character on the
book cover. If the child pointed to the wrong character, she was corrected and asked to point again. All children pointed to the correct characters. Table 5 presents the property origins for each of the target properties.

Table 5. Target Properties Used in Experiment 4

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Character Properties Condition</th>
<th>Kind Properties Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debbie the Doble</td>
<td>A tail on her back</td>
<td>She put it there</td>
<td>She was born with it</td>
</tr>
<tr>
<td></td>
<td>Wings on her back</td>
<td>She put it there</td>
<td>She was born with it</td>
</tr>
<tr>
<td>Felix the Fargle</td>
<td>A horn on his back</td>
<td>He put it there</td>
<td>He was born with it</td>
</tr>
<tr>
<td></td>
<td>A stripe on his back</td>
<td>He put it there</td>
<td>He was born with it</td>
</tr>
</tbody>
</table>

**Test Phase.** The experimenter opened the storybook to the page where the target properties were displayed on the back of the target character. She told the child that the illustration was of the target character, and pointed out the first of two target properties. For example, she said, “Remember, this is Debbie, the doble. Now look closely: she has a tail on her back.” Then she explained the origin of the property, depending on the condition to which the child was assigned. For the “tail” property, children in the character properties condition heard, “In the story, Debbie has a tail on her back because she put it there.” Children in the kind properties condition heard, “In the story, Debbie has a tail on her back because she was born with it.” The experimenter repeated the information about the property and its origin twice. Although there is some evidence that children do not distinguish properties that are inborn from
those that are put on (Gelman & Bloom, 2007), there is evidence that children at least understand that kind properties tend to be present at birth (Gelman & Kremer, 1991; Springer & Keil, 1989).

After learning about the first target property, the experimenter pointed to each of the test objects in turn and asked the child if he thought it had the test property. For example, the experimenter pointed to the character-match toy and said, “Look here! This is Debbie, the doble from the story. Do you think this one has a tail on its back?” Once the child answered “yes” or “no”, the experimenter asked the same question of the next test object. After the third test object, the experimenter moved onto the next target property, repeating the method described above. After both target properties were queried of the first storybook, the entire method was repeated for the second storybook. In total, four target properties were queried of each test object.

**Results**

We predicted that children in the *character properties* condition would answer “yes” to the character-match toy, and “no” to the other two test objects. Such a pattern would indicate an understanding that properties stemming from the representation’s abstract character identity would extend to another representation of the same character, but not to a representation of another character. We predicted that children in the *kind properties* condition would answer “yes” to both the character-match toy and the kind-match toy, but not to the distracter. This pattern of results would demonstrate an understanding that properties stemming from the representation’s kind identity would extend to other representations of the same kind, but not to representations of another kind of animal.
ANOVA Analysis

As in Experiment 3, children were given a score out 4 for each test object (character-match, kind-match, or distracter), corresponding to the number of “yes” responses to that test object. Children’s responses in both conditions were consistent with our predictions: in the character properties condition, the tendency to say “yes” was highest to the character-match test question ($M = 2.44; SD = 1.97$) and low to the kind-match ($M = .30, SD = 1.21$) and distracter ($M = 0$, no variance); in the kind properties condition, the tendency to say “yes” was high for both the character-match ($M = 3.25, SD = 1.61$) and the kind-match test questions ($M = 2.31, SD = 1.81$), and low for the distracter ($M = .06, SD = .25$). See Figure 11. To investigate the observed trends, these data were subjected to a 3 (test-object: character-match, kind-match, distracter; within-subjects) by 2 (sex: male, female; between-subjects) by 2 (condition: character properties, kind properties; between-subjects) ANOVA. This initial analysis revealed a significant main effect of test object, $F (2, 56) = 39.27, p < .001, \eta_p^2 = .58$, a significant main effect of condition, $F (1, 28) = 6.20, p = .02, \eta_p^2 = .18$ and a significant interaction between these two factors, $F (2, 56) = 3.43, p = .04, \eta_p^2 = .11$.

To understand this interaction, we computed simple main effects of condition at each level of test object. Consistent with our predictions, the two groups did not differ in their responses to the character match test object, $F (1, 28) = 1.88, p = .18, \eta_p^2 = .05$, nor did they differ in their response to the distracter test object, $F (1, 28) = .01, p = .92, \eta_p^2 = .03$, but they differed significantly in their response to the kind-match test object, $F (1, 28) = 9.39, p = .005, \eta_p^2 = .27$. 
Comparisons to Chance

To compare performance in each condition to chance, we performed six single-sample directional t-tests, using a Šidák-corrected critical p-value of .0085. In the character properties condition, we predicted that the mean response to the character-match object would be above chance, and those for the kind-match and distracter would be below chance. We found that the mean for the character-match object was not significantly higher than chance, \( t(15) = .89, p = .20, d = .22 \), but the means for the kind-match object and the distracter were significantly below chance (kind-match, \( t(15) = -4.95, p < .001, d = 1.24 \); no children in this condition responded “yes” to the distracter, so statistics cannot be computed due to lack of variance). In the kind properties condition, we predicted that the mean response to the character-match and kind-match objects would be above chance, whereas the mean response to the distracter would be below chance. We found that the mean for the character-match object was above chance, \( t(15) = 3.10, \)
$p = .004, d = .78$, the mean for the kind-match was not significantly higher than chance, $t (15) = .69, p = .25, d = .17$, and the mean for the distracter was below chance, $t (15) = -31.00, p < .001, d = 7.75$.

**Non-Parametric Analyses of Individual Response Patterns**

To shed more light on children’s patterns of responding, each trial was categorized as revealing a *character pattern* if the child extended the property to the character-match but not to the kind-match or distracter, and a *kind pattern* if the child extended the property to the character-match and the kind-match, but not to the distracter. Additionally, a third pattern that we considered was an *object pattern*, characterized by the child refusing to extend the property to all three test objects. Any other pattern was designated uninterpretable and not included in this analysis. Each child who had the same pattern on at least three out of four trials was then categorized according to her modal pattern as a character responder, a kind responder, or an object responder. This classification captured 30 out of 32 children; the other 2 were excluded from this analysis. In the *character-properties condition*, 8 children were character responders, and 1 was a kind responder. Additionally, 6 children were object responders. In the *kind-properties condition*, 9 children were kind responders, 3 children were character responders, and an additional 3 were object responders. See Figure 12. A chi square test comparing the proportion of character responders versus any other pattern across the two conditions approached significance, $\chi^2 (2, N = 32) = 3.59, p = .06, \phi = .35$, and a second chi-square test comparing the proportions of children who were kind responders versus any other pattern across the two conditions was significant, $\chi^2 (2, N = 32) = 9.60, p = .002, \phi = .57$. These results provide further support for our findings that children behaved differently across the two conditions.
Discussion

Experiment 4 replicated and extended the results of Experiments 2 and 3. Children in the character properties condition, as in Experiments 2 and 3, extended properties that were described as originating in the character’s history to another representation of the character, but not to a representation of a different character of the same kind. Of greatest interest, children in the kind properties condition extended properties that were described as originating at the character’s birth to other representations of the same character, and to representations of another character belonging to the same kind. No children extended properties to a representation of a character belonging to a different kind. These results provide new evidence that children can flexibly construe an object as not only a physical individual and an instantiation of an abstract character, but also as a member of a kind. Moreover, preschool children can use information
about property origins to map the very same properties onto either an abstract character or a kind, and make correct inductive inferences based on that mapping.

One intriguing result arising from this study was the finding that 6 out of 16 children in the character-properties condition and 3 out of 16 in the kind-properties condition did not generalize the properties to any of the test objects, suggesting that they interpreted the character properties as being idiosyncratic to the target representation of the character. This finding reveals a hesitation on the part of some children to extend properties beyond the target representation, and it is related to the finding that the mean number of “yes” responses was only significantly higher than chance in one of the three instances where it was predicted to be high (i.e., to the kind properties condition/character-match test object, but not the kind properties condition/kind-match test object or the character properties condition/character-match test object). A similar baseline tendency to restrict properties was observed in Experiment 3, where children in the story properties condition did not extend the properties to the story-match-identical test object at a rate significantly higher than chance. While both experiments revealed significant differences between children’s behaviour across conditions, in neither experiment did children ever display at- or near-ceiling responding.

There are at least two possible interpretations of this result. First, it may indicate that children have a strong early bias to interpret idiosyncratic properties as belonging to spatio-temporally discrete physical individuals. In turn, it may take extra effort for children to overcome their bias to construe two instantiations of an abstract individual as distinct individuals, leading them to err on the side of underextending, rather than overextending. This explanation is supported by Gutheil et al.’s (2008) finding that children have a strong tendency to construe multiple representations of a fictional character as discrete individuals. Second, the observed
result may simply reflect a conservative bias on children’s part to restrict a property rather than extend it. That is, rather than having a conceptual bias to construe target and test objects as discrete individuals rather than as abstract individuals, children who were unsure whether or not the properties should generalize simply opted for the more conservative response, and answered “no”.
GENERAL DISCUSSION

In four experiments, four- and five-year-olds demonstrated that they could use the abstract identity of a fictional character or an intellectual object as a basis for inferring the presence of certain physical properties in multiple physical instantiations of the individual. In Experiment 1, children extended a character property (e.g., a banana tattoo that a monkey character received when he was a baby) from one toy representation of a character to another same-named toy when the two toys were described as sharing a character identity, but not when they were described as coincidentally sharing a name. In Experiment 2, children distinguished between properties that belonged to a representation of a character in virtue of its character identity (e.g., a banana tattoo that the monkey character received when he was a baby) and those that belonged to it in virtue of its unique spatiotemporal history (e.g., a banana tattoo that the experimenter’s friend drew on a representation of the monkey character in a storybook), extending only character properties to another representation of the character. In Experiment 3, children distinguished between properties that belonged to a copy of an intellectual work in virtue of its abstract story identity (e.g., an illustration of a mitten that belonged to a character in a storybook) from those that belonged to it in virtue of its unique spatiotemporal history (e.g., an illustration of a mitten that the experimenter drew on the storybook), extending only story properties to another copy of the book, but not to a copy of a different book. Finally, in Experiment 4, children distinguished between properties that belonged to a representation of a character in virtue of its character identity (e.g., wings that a character affixed to herself) and those that belonged to a representation of a character in virtue of its kind identity (e.g., wings that a character was born with), extending character properties to another representation of the same character, and extending kind properties to both another representation of the same character and
to a representation of another fictional individual of the same kind, but extending neither kind of property to a representation of a character belonging to a different kind. The following sections will reconsider the themes raised in the introduction in light of the present findings.

**Multiply Instantiated Abstract Individuals**

Recent research has revealed that children rely heavily on spatiotemporal evidence when making inferences pertaining to individual identity (Gutheil et al., 2008; Hall et al., 2001; Hood & Bloom, 2007). For example, Gutheil et al. found that children treated two toy representations of the same character as distinct individuals, and attributed to them distinct knowledge-state properties. The present findings indicate that young children are able to look past an object’s unique spatiotemporal history when inferring some of its idiosyncratic properties. Children readily extended character properties from one representation to another, despite the representations’ spatiotemporal distinctiveness, when the representations shared an identity at the level of the character. The abstract character identity thus supplied a further foundation for inferring some of a representation’s properties. Children likewise extended properties from one instantiation of an abstract intellectual object to other, spatio-temporally distinct instantiations of the same abstract work, including both identical-looking and different-sized copies.

These findings show not only that children can construe multiply instantiated individuals as having a shared abstract individual identity that is distinct from their discrete object identity, but also that children treat this shared identity as distinct from a shared kind identity. A majority of the literature on children’s inductive inference behaviour has examined children’s use of richly-structure kinds to support inductive inference (e.g., Gelman, 1988, 2003; Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Keates & Graham, 2008; Welder & Graham, 2001). The present studies provide the first evidence that preschoolers can draw inductive
inferences that are supported by \textit{individual} identity. Two pieces of evidence from the present experiments allow us to distinguish these two bases for inductive inference. First, children in Experiment 3 who learned a story property belonging to a copy of an intellectual work used the shared story identity as a basis for extending the property to other instantiations of the same individual, but almost never extended the property to other objects belonging to the same kind, indicating an ability to distinguish inference based on individual identity from that based on kind identity. Second, children in Experiment 4 who learned a novel property belonging to a fictional character \textit{only} extended the property to another member of the same kind if the property was described as inborn. When it was described as idiosyncratic, children still tended to extend the property, but in this case they used shared individual identity, rather than shared kind identity, as the basis for the inference.

Taken together, the present studies provide robust evidence that children reason aptly about multiply instantiated individuals, treating them as unique individual objects or as instantiations of a shared abstract individual identity, as appropriate. Moreover, children’s inferences based on shared abstract identity were markedly different from those based on shared kind identity and also from those based on unique physical object identity.

\textbf{Conceptual Flexibility and Inductive Inference}

The reasoning ability we examined in this research is a specific example of a more general capacity to think flexibly about an object on multiple conceptual levels. Several previous results from the developmental psychology literature suggest that children as young as four years possess this capacity: their patterns of property extensions in inductive inference tasks indicate that they are capable of construing the same material object as a unique individual, as an instance of an object category, or as a portion of a material category (e.g., Deák & Maratsos, 1998; Deák,
The current results are consistent with those past findings. At the same time, our findings reveal that young children’s conceptual flexibility is even broader in scope, in that it also enables them to draw inferences about certain objects construed as unique individuals, as instantiations of abstract individuals, or as instances of a kind.

The present findings provide a challenge to Sloutsky and Fisher’s (2004) SINC (Similarity, Induction, Categorization) model of children’s inductive inferences. This theory suggests that, for young children, the factors underlying similarity judgments are the same as those underlying inductive inference and categorization. The model thus predicts that a pair of objects that are more similar to each other (on whatever set of dimensions children attend to, including shared labels) should be both more likely to support children’s inductive inference, and also more likely to be judged to belong to the same category. The present studies did not assess children’s categorization, but they do provide evidence that children’s inductive inference behaviour is independent of both category membership and object similarity. This evidence comes from all four experiments.

First, children across conditions of Experiment 1 saw the same target and name-match objects, which were given the same shared label. Recall that the only difference between the two conditions was the character-to-toy mapping: children were taught either that the two purple monkey toys represented the same character, or that they represented two characters who coincidentally shared a name. Children displayed a significant tendency to draw inductive inferences from the target to the name-match only when they shared an abstract individual identity (cf. Heyman & Gelman, 2000). In this case, similarity was constant across the two conditions (i.e., the objects and their names were the same), and category membership was
constant across the two conditions (i.e., the objects were both monkeys). Individual identity differed across conditions, and it predicted patterns of inductive inference.

Second, in Experiments 2-4, children across conditions saw the same target and test objects, which were given the same names and represented the same characters and kinds. In these experiments, the only difference across conditions was the description of the origin of the target property, which either pertained to the object’s status as a discrete physical individual (Experiments 2-3), its status as an instantiation of an abstract individual (Experiments 2-4) or its status as an instance of a kind (Experiment 4). In these experiments, whether children extended a property from the target to a test object was predicted by the property’s relevance to the shared individual or kind identity between a given test object and the target.

In conjunction with previous research, the present findings suggest that children have an impressive capacity to flexibly construe objects as physical individuals, instances of abstract individuals, and instances of both natural kinds and arbitrary object categories. Moreover, children’s inductive inferences appear to be based on a rich understanding of a property’s relevance to a particular level of identity, a finding that may be difficult to explain by appealing to similarity.

**Children’s Sensitivity to Property Origins**

Until now, there has been very little evidence that preschoolers attend to information about the origin of an object’s properties when determining the scope of those properties’ generalization. Some research has shown that children show some sensitivity to property *type* in inductive inference tasks, for example, children recognize that idiosyncratic properties (e.g., “has a piece of grass stuck to it”) do not generalize, kind properties (e.g., “has a spleen inside”)
generalize to other kind members, dispositional properties (e.g., “gets sodden in water”) generalize to objects made from the same substance, functional properties (e.g., “used for accelerating”) generalize to other artifact kind members, and situational properties (e.g., “eaten on a holiday called dax”) generalize to situationally-related objects (Gelman, 1988; Gelman & Markman, 1986; Kalish & Gelman, 1992; Nguyen & Murphy, 2003).

To successfully establish the scope of an inductive inference based on property type, as in the examples just listed, children must have some ability to connect a particular type of property with a construal of an object as an individual, or as a member of a natural or artifact kind, substance kind, perceptual category, or situational category. Experiments 2-4 tested children’s ability to connect a property with a particular construal of an object based on direct information about the source of the property, keeping the property itself constant across conditions. In Experiments 2 and 3, we presented children with idiosyncratic properties (e.g., “has a banana tattoo on his ear”) that were identical across conditions, but described alternately as stemming from the individual object identity (e.g., the experimenter drew it on the representation in the book) or as stemming from the abstract individual identity (e.g., the character got it as a child). In Experiment 4, we presented children with properties that are typically kind-referring (e.g., “has wings on her back”) that were described alternately as stemming from the abstract individual identity (e.g., the character put them on) or as stemming from the abstract kind identity (e.g., the character was born with them).

The only other study to have explicitly varied property origins as we did in Experiment 4 was reported by Gelman & Bloom (2007), who also presented children with typically kind-referring properties (e.g., having claws) and varied whether they were said to stem from individual identity (e.g., some dobles put them on) or from kind identity (e.g., they were born
with them). In their study, preschoolers did not differ in their behaviour on the task based on property origins. It is not clear why children’s sensitivity to property origins appeared in the present experiments but not in Gelman and Bloom’s study, but it may be related to overall task demands of the studies. There were several differences between our task and Gelman and Bloom’s that might underlie children’s relative success in our task compared to theirs. First, Gelman and Bloom’s design involved a fully within-subjects manipulation, which may have increased the processing burden on children such that they were unable to fully attend to property origins. Second, children in Gelman and Bloom’s task were always asked to generalize from a group of creatures, rather than from a single creature. This aspect of their design may have blocked children to some degree from interpreting properties as idiosyncratic, given evidence that the properties were true of multiple instances of the kind. Third, Gelman and Bloom asked children to make generic inferences by endorsing statements such as “Dobles have claws,” whereas the present task involved demonstrating the generic inference by extending a property to another instance of the kind. Though these tasks aim to access the same underlying belief (i.e., the belief that the property should be common among instances of the kind), children’s propensity to endorse a generic statement may be a less sensitive measure of this belief. Whatever the reason for children’s insensitivity to property origins in Gelman and Bloom’s study, the present studies provide new evidence that preschool-aged children are sensitive to information about property origins when establishing the scope of inductive inference.

**Developmental Origins**

This work has revealed that preschool-aged children in an urban North American setting can reason in sophisticated ways about multiply instantiated objects. What is the origin of
children’s ability to construe an object as one of many instantiations of an abstract individual? One possibility is that it is learned; that is, experience with multiply instantiated objects is necessary for children to reason aptly about them. If learned, understanding of multiply instantiated individuals may be a gradual developmental process, or it may be the result of a rapid insight. Another possibility is that children’s understanding of multiply instantiated individuals may come as the result of maturational processes, independent of experience with these objects. We consider these possibilities in turn.

First, children’s understanding of multiply instantiated individuals that is documented in these experiments may be acquired through experience with representational objects and other instantiations of abstract individuals. To be sure, children raised in North America tend to have an enormous amount of experience with not only character toys, but also books, movies, chain restaurants and stores, and brand-named artifacts. It seems likely, then, that children’s success in the present tasks depended at least partly on their familiarity with the sorts of objects presented. Having daily experience with multiple instantiations of abstract individuals would accustom children to the sorts of properties that these objects tend to share, and those that tend to be unique.

Support for the hypothesis that this understanding is learned comes from the literature on children’s understanding of representations. Researchers examining children’s pictorial competence have suggested that children need to learn the representational status of pictures and videos (e.g., Deloache, Pierroutsakos, & Troseth, 1996; Deloache, Pierroutsakos, & Uttal, 2003; Troseth & Deloache, 1998). According to this research, although even the youngest infants treat pictures differently than they treat the objects those pictures represent, they do not fully understand the representational nature of pictures or video until they are toddlers. Between 9 and
19 months, children’s behaviours toward pictures changes dramatically. Over this time, children learn not to attempt to interact directly with pictorial representations and instead to treat them as depictions. If this slow development is linked with infants’ experience with pictures, then the same sort of experience would surely be necessary for children to understand representational toys.

Although some of the research on children’s developing understanding of representations indicates a gradual experience-based change, other evidence suggests that aspects of this understanding may be achieved in bursts of insight that may be universal (Deloache, 1987; Deloache, Miller, & Rosengren, 1997). Deloache and her colleagues have argued that children’s understanding of the representational nature of scale models is one example of very rapidly-developing knowledge. Deloache, Miller, and Rosengren presented two-and-a-half-year-olds with a scale model of a room. Children saw the location of a hidden toy on the model, and were tasked with finding the toy in the room, and vice versa. One group of children saw the model and the room simultaneously, and they heard an explicit description of the relation between the two spaces. A second group of children never saw the room and the model together, and were instead told that the big room was able to shrink to turn into model. Children who believed the room to shrink into the model were much more competent at finding the hidden toys than children who knew that the model was not the room.

Deloache and her colleagues argued that this task reveals a deficit in young children’s symbolic understanding that they overcome just months later, by age three (Deloache, 1987; Deloache et al., 1997). In the interim, children undergo a realization that a representational object, such as a model of a room, is at once a material object and a representation of something else – that is, they have an insight that allows them to recognize the dual identity of
representational objects. Deloache (1987) suggested that the rapidity of children’s representational insight may indicate a maturational basis to this understanding: that children were nearly universally successful at three years suggests a universally developing ability that may be independent of experience. However, this insight comes far from delivering a broad understanding of all representational relations. Research on children’s ability to use pictures, maps, aerial photographs, and videos shows that these abilities all develop at different points in childhood, suggesting that children may experience a series of increasingly complex insights over the course of early childhood (Bluestein & Acredolo, 1979; Deloache & Burns, 1991; Liben & Downs, 1993; Troseth & Deloache, 1998).

As with understanding the representational relation between a model and a room, understanding the individual identity relation between several instantiations of an abstract individual also requires that children recognize the dual identity of objects. The present studies show that, by four to five years, children can construe multiply instantiated objects as having a dual individual identity, that is, having an individual identity at both the level of the physical object and the level of the abstract individual. It seems likely that the same sort of representational insight that allows for children to successfully construe a model room as a representation of a bigger room may also allow them to construe multiply instantiated individuals.

If children’s understanding of multiply-instantiated individuals is achieved in a maturationally-based insight, then their experience with these objects should play little role in their ability to reason aptly about them. This would suggest that children’s concepts of individuals allow for the possibility of multiple instantiations from the beginning. There are at least two ways in which it would be possible to test this hypothesis.
First, children raised in a culture lacking books, representational toys, brand-name artifacts, and other media, would nonetheless succeed at the tasks presented here. One way to evaluate this possibility would be through cross-cultural research. For example, many cross-cultural researchers have studied the Itzaj Mayan tribe who live in the rainforests of Guatemala (e.g., Coley, Medin, & Atran, 1997; López, Atran, Coley, Medin, & Smith, 1997), because their radically different life experiences allow for a powerful test of differences in reasoning across levels of experience. If Itzaj children have limited access to multiply instantiated objects and they show similar patterns of inductive inference across multiply-instantiated individuals as the children reported here, that would provide strong evidence for a limited role of experience in the acquisition of that understanding.

Second, if the ability to construe multiply instantiated individuals as sharing an abstract identity and to make inductive inferences on that basis is independent of experience, then individual variation in this ability in North American children should be unrelated to their level of experience with multiply instantiated objects. Children’s responses in the present experiments were highly variable: there were young four-year-olds who reasoned successfully, and old five-year-olds who showed no sign of understanding. The mere fact that this variability exists across such a large developmental time span suggests that a purely maturational story may not be sufficient to account for children’s success in our task. However, individual variability need not be related to experience; it could be due to variability in more general cognitive factors, such as processing speed and memory. To investigate the role of experience, then, it would be necessary to measure children’s level of experience (for example, by administering a questionnaire to the children’s parents regarding time spent with various media, and the number of character toys in the house) in addition to having them complete the inductive inference tasks presented here. A
correlation between children’s responses to the inductive inference task and their amount of
experience with multiply instantiated objects would suggest that experience plays a role in the
development of this ability. Such an analysis would require much larger sample sizes than those
used in the present experiments, to ensure a stable correlation coefficient and sufficient power to
find a correlation, should one exist.

Future Directions

The study of children’s concepts of individuals is young. The vast majority of research on
children’s concepts has focussed on their understanding of richly structured kinds. Unlike
individuals, it may seem, kinds are abstract and intangible, and it is mysterious how children
come to conceive of abstract kinds given only concrete examples. Only recently have researchers
have begun to examine children’s concepts of individuals, revealing that these concepts, too, far
from being straightforward representations of concrete things, are complex and nuanced. Until
now, however, what was known of children’s concepts of individuals is that they were bound by
the spatiotemporal continuity of physical objects. The present research has found that children
overcome these limits to construe an individual as being instantiated in many spatiotemporally
distinct physical objects, and use this shared identity to support inductive inference. Children’s
concepts of individuals are far more flexible than they previously seemed. These findings raise
certain questions and provoke new ideas for future research.

One question of interpretation concerns the extent to which children in the present
experiments can be said to show true conceptual flexibility. Nguyen (2007) has argued that the
between-subjects design used in the present experiments does not support the conclusion that
children can simultaneously represent an object at two conceptual levels, because no single child
ever had the opportunity to make more than one construal of an object. In order for conceptual
flexibility to be maximally useful for a child, Nguyen argued, the child needs to be able to construe an object at two different conceptual levels at the same time. To use her example, a child who is lactose intolerant and choosing a dessert must simultaneously construe a dish of ice cream as dessert and as a dairy product. Nguyen assessed this ability for simultaneous construal in three- to six-year-old children by asking them to endorse compound nouns that contained information about two overlapping categories, for example, by asking children, “Are pyjamas bedtime clothes?” versus, “Is a library a bedtime building?” By 4 years, children successfully endorsed appropriate category labels and denied inappropriate ones.

Because abstract object instantiations do not have names qua physical individuals (e.g., a Batman doll does not have a unique name that distinguishes it from other Batman dolls), it would be hard to adapt Nguyen’s (2007) method precisely to the abstract individual concepts under consideration here. However, an experiment in which children were asked, for example, to retrieve “the small Batman doll” versus “the large Batman doll,” “the small Superman doll” or “the small Batman book” would be telling. To succeed at this task, children would have to simultaneously represent three levels of identity in each object—its unique object identity (e.g., to distinguish “small Batman doll” from “large Batman doll”), its abstract character identity (e.g., to distinguish “small Batman doll” from “small Superman doll”), and its kind identity (e.g., to distinguish “small Batman doll” from “small Batman book”).

Setting aside Nguyen’s strict criteria of demonstrating simultaneous construal of an object at two conceptual levels, it would also be worthwhile to demonstrate that children can switch back and forth between two construals by examining this conceptual flexibility within a given child. The between-subjects design of the present experiments did not allow us to assess the conceptual flexibility of any individual child; instead, we based the conclusion that children...
are capable of many different levels of construal on group differences. A within-subjects design would have allowed us to assess conceptual flexibility more directly. Unfortunately, pilot testing using a within-subjects design revealed that children were often unwilling to switch response patterns after the first trial. This finding is not altogether surprising, given research suggesting that young children lack the executive control to inhibit one response pattern and switch to another (e.g., Zelazo, Müller, Frye, & Markovich, 1998). In the present studies, our manipulation was subtle: across all conditions, we used exactly the same properties described in the same way, varying only a sentence about their origin. By clearly demonstrating the property origins to children, it may be possible to make the manipulation salient enough for children to respond to it even in a within-subjects design. For example, if an experimenter read a storybook with children in which the main character was depicted acquiring a property (e.g., a banana tattoo) in childhood and growing up with it, and then children witnessed the experimenter drawing a second property (e.g., a heart) on a representation of the character in the book, children may be more likely to attend to and reason about those property origins when making inferences to another representation of the character. Additionally, inserting an intervening task between trial blocks may distract children enough to attenuate their response biases. Manipulations such as these may allow children’s conceptual flexibility to manifest itself more readily.

A second avenue for future research will entail examining children’s understanding of other kinds of multiply instantiated individuals. Perhaps most ubiquitous of these are artifacts that represent an individual brand model, including articles of clothing, electronic goods, and vehicles. For instance, every Nike Air Skyraider shoe has a mesh upper with supportive overlays, a dual-density mid-sole, and special carbon rubber at the heel in virtue of its identity as a particular model, but each one may have its own flaws, scuffs, and stains in virtue of its unique
spatiotemporal history. Furthermore, the brand model identity of these objects depends on the origin of the model-relevant properties. Authentic representations must come to possess these properties through a legitimate process (e.g., production in a Nike factory); objects that acquire the same properties in any other way are knockoffs. As in the case of character toys and intellectual objects, children must learn to reason aptly about these other types of artifacts, recognizing which of their properties are relevant to each level of individual identity. The current findings suggest that young children possess the necessary conceptual flexibility to do so, but it remains a project for future research to probe directly children’s grasp of the complexity involved in thinking appropriately about these objects.

To be sure, many of the objects in young children’s experience are not instantiations of abstract individuals. In particular, most of the people children encounter on a daily basis are non-representational, including their parents, friends, and teachers. Reasoning about these entities does not require the ability to construe them at two distinct levels of individual identity. Despite this fact, the general need to think flexibly about such people (and other non-representational objects) under multiple conceptual descriptions certainly does arise, because these entities can be construed either as unique individuals or as instances of various different categories (e.g., a woman may be construed as Mrs. Jones or as a person, a teacher, a singer, or a vegetarian.) The present research has documented that children are capable of flexibly construing an individual not only as a unique physical individual and as an instance of an abstract individual, but also as a member of a kind.

Young children also occasionally need to reason about people as embodiments of abstract individuals, for example, when they observe human actors playing the role of fictional characters on television, on stage, and in film. A particularly interesting avenue for future research would
be to examine young children’s understanding of cases of multiple individuals instantiated in a single person. The current findings suggest that children may have little trouble distinguishing between the properties that pertain to a fictional character played by an actor (e.g. Voldemort is evil) and those that belong to the actor by virtue of his unique history (e.g., Ralph Fiennes is philanthropic). Teasing apart two sets of human-relevant properties in a single person may, however, turn out to be harder than distinguishing object properties from character properties in toys. Hawkins (1977) reported that children’s understanding of the distinction between actors and characters on television increases dramatically between six and 11 years, with younger children more likely to agree that, for example, police officers on television are police officers in real life (see also Nikken & Peeters, 1988; Wright, Huston, Reitz, & Piemyat, 1994). Anecdotal reports of fans requesting medical advice from actors who play fictional doctors on television suggest that the keeping these two identities separate may be a difficult task, even for some adults. Reasoning appropriately about people who possess an individual identity at multiple levels of abstraction thus may present a persistent challenge well beyond early childhood.
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APPENDIX A: TEXT OF ILLUSTRATED STORYBOOK, “BORIS AND THE TIGER’S TRAP,” FROM EXPERIMENT 1

[Page 1] Once, there were three monkeys. One was called Boris, and his best friends were called Igor (in character-shared name condition) [Boris (in accidentally-shared name condition)] and Fred. Boris, Igor [Boris], and Fred. Isn’t that silly? Boris was a monkey who liked to do silly things like swing around in the trees and tease the tigers in the jungle.

[Page 2] Boris had a banana on his ear that he got when he was a baby, and a pink heart on his back that he got from his mother. He also had a mark on his back that he got when the tiger was chasing him, and a dark patch on his bum that he got from falling out of a tree.

[Page 3] There was one tiger in the jungle who really didn’t like Boris, and he made a plan to catch Boris in a trap. He dug a big hole, filled it up with wet, sticky mud, and covered it up with sticks and leaves. But guess who was watching? Boris’s friends, Igor [Boris] and Fred were watching from up in their tree! They watched as the tiger built his trap.

[Page 4] The tiger started to chase Boris toward the trap so that Boris would fall into the mud hole. But Igor [Boris] and Fred were still watching from their tree, and they knew what the tiger was planning. So when the tiger started to chase Boris toward the trap, Igor [Boris] and Fred swung down from their tree and lifted Boris into the air. They carried him safely into the tree.

[Page 5] The tiger was so surprised that he kept running, and fell into his own trap! Boris, Igor [Boris], and Fred all laughed at the tiger, who was all covered in mud.
Certificate of Approval

PRINCIPAL INVESTIGATOR
Hall, D.G.

DEPARTMENT
Psychology

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT
UBC Campus,

CO-INVESTIGATORS:
Belanger, Julie, Arts; Chan, Kathy, Psychology; Cheung, Wendy, Psychology; Co, Elaine, Psychology; Corrigall, Katie, Psychology; Lavin, Tracy, Arts; Khemtula, Mijke, Psychology

SPONSORING AGENCIES
Natural Science Engineering Research Council

TITLE:
Word Learning in Childhood

APPROVAL RENEWAL DATE
OCT - 4 2005

TERM (YEARS)
1

CERTIFICATION:

The protocol describing the above-named project has been reviewed by the Committee and the experimental procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval of the Behavioural Research Ethics Board by one of the following:
Dr. Peter Suedfeld, Chair,
Dr. Susan Rowley, Associate Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures.
# Certificate of Approval

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<th>NUMBER</th>
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<td>Hall, D.G.</td>
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**INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT**

UBC Campus,

**CO-INVESTIGATORS:**

Leung, Dily, Psychology; McNiven, Cristy, Psychology; Rhemtulla, Mijke, Psychology

**SPONSORING AGENCIES**

Natural Science Engineering Research Council

**TITLE:**

Word Learning and Conceptual Development

**APPROVAL DATE**

SEP 14 2006

**TERM (YEARS)**

1

**DOCUMENTS INCLUDED IN THIS APPROVAL:**

August 1, 2006, Advertisement / Contact letter / Consent form / Questionnaires

The application for ethical review of the above-named project has been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

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*Approved on behalf of the Behavioural Research Ethics Board by one of the following:*

- Dr. Peter Suedfeld, Chair,
- Dr. Jim Rupert, Associate Chair
- Dr. Arminee Kazanjian, Associate Chair
- Dr. M. Judith Lynam, Associate Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures.
CERTIFICATE OF APPROVAL - FULL BOARD

PRINCIPAL INVESTIGATOR(S):  
David Geoffrey Hall

INSTITUTION / DEPARTMENT:  
UBC/Arts/Psychology, Department of

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:  
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CO-INVESTIGATOR(S):  
Mijke Rhemtulla  
Danielle K. Kingdon  
Dilys Leung

SPONSORING AGENCIES:  
Natural Sciences and Engineering Research Council of Canada (NSERC) - "Word Learning and Conceptual Development in Childhood"

PROJECT TITLE:  
Word learning and conceptual development in childhood

REB MEETING DATE:  
August 13, 2009

CERTIFICATE EXPIRY DATE:  
August 13, 2010

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Consent-Study 6-(Fiction)-Adult-Money | N/A | July 31, 2009 |
Consent-Study 1-(Individuation)-Children-Centre | N/A | July 31, 2009 |
Consent-Study 7-(Part Change)-Adult-Credit | N/A | July 31, 2009 |
Consent-Study 5-(Twins)-Children-Centre | N/A | July 31, 2009 |

PROTOCOL:

Protocol:  
Protocol-Study 1-(Individuation)  
Protocol-Study 5-(Twins)  
Protocol-Study 3-(Range of Reference)  
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Protocol-Study 8-(Disassembly)  
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Protocol-Study 4-(Social Groups)

Consent Forms:  
Consent-Study 8-(Disassembly)-Adult-Money  
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Consent-Study 6-(Fiction)-Children-Centre  
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PROTOCOL:

Protocol:

Consent Forms:

CONSENT FORMS:

PROTOCOL:

CONSENT FORMS:
The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair  
Dr. Ken Craig, Chair  
Dr. Jim Rupert, Associate Chair  
Dr. Laurie Ford, Associate Chair  
Dr. Anita Ho, Associate Chair