FLUENCY MISATTRIBUTION AND THE CURSE OF KNOWLEDGE BIAS IN CHILDREN

by

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Abstract

The ability to judge what information other people are likely to know is vital to successful communication and social interaction. The curse of knowledge is the tendency to be biased by one’s knowledge when attempting to reason about a more naïve perspective. The current study sought to determine the role fluency misattribution plays in the curse of knowledge bias in children. Fluency misattribution occurs when the subjective feeling of ‘fluency’ associated with familiar, or easy-to-process, information gets misattributed when making various judgments. Applied to the curse of knowledge, fluency misattribution occurs when one’s feeling of fluency is misinterpreted as the information being objectively obvious or widespread. In the current within-subjects design 115 children aged four to seven were read stories involving two groups of animals, and were asked to judge whether their peers would know more about one group or the other. I tested fluency misattribution by manipulating the frequency with which participants heard about the animals, frequently throughout or only once. The results revealed that increasing the frequency with which the information was presented lead children to over-attribute how common that knowledge was among their peers. I also tested participants on curse of knowledge and source monitoring tasks, revealing a positive correlation between children’s fluency misattribution and source monitoring, and no relationship between fluency misattribution and performance on the curse of knowledge task. I discuss how these findings contribute to the field of social cognition, especially our understanding of the mechanisms involved in reasoning about what others know.
Preface

The study included in this thesis contains original, unpublished work by the author, Taeh Bonn Haddock. The research presented here was approved by the University of British Columbia’s Behavioral Research Ethics Board (Project Title: Social Learning and Social Judgments, H12-03323).
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Dedication

I would like to thank my mom for always being my biggest fan, and believing in my abilities even if I was unable to see them in myself. I would like to thank Bruce for his unwavering support and encouragement along the way. Finally, I would like to thank my dad for remaining by my side and instilling me with the belief to always move forward and follow your dreams.
Fluency Misattribution and the Curse of Knowledge Bias in Children

Consider the following anecdote: The morning recess bell rings and the children gather around the playground to begin a game of ‘grounders’ that they play everyday. A boy new to the school sees the game ensue while observing cautiously from the sidelines. The other children encourage the boy to join in and are shocked to learn that he does not know how to play. I hypothesize that one reason for the children’s shock at the boy’s ignorance is because the rules of the game are particularly familiar to them since they play it everyday. Thus, they misattribute their familiarity with the game to it being familiar to others and erroneously assume it is more widely known than it actually is.

The ability to reason about what others know, or are likely to know, is critical for making sense of others’ actions and is called upon in many social interactions. Knowledge attribution is a key component of ‘social perspective-taking’ or ‘theory of mind’ (i.e., a set of processes involved in inferring and reasoning about the mental states of others, such as their knowledge, beliefs and intentions). Theory of mind is especially important because it allows us to interpret and predict the actions of others and is critical for successful communication. Individuals who exhibit more accurate theory of mind abilities demonstrate a host of positive outcomes. For example, advanced understanding of the mind can lead to more sophisticated social and emotional understanding (Harwood & Farrar, 2006; Watson, Nixon, Wilson, & Capage, 1999; Cutting & Dunn, 2002), as well as fewer relationship problems, higher academic achievement, more prosocial behavior, increased social competence, and better quality of life (see Chandler & Birch, 2010; Flavell, 1999; Hughes & Leekam, 2004; Wellman & Lagattuta, 2000 for reviews).

To effectively communicate with others one must make inferences about what others already know in order to gauge what information needs explanation or elaboration and what
Despite the importance of knowledge attribution, it remains remarkably prone to error throughout development and across the lifespan. One limitation in particular, the ‘curse of knowledge’ bias, refers to the difficulty in reasoning about a more naïve perspective as a result of being biased by one’s own knowledge. This bias occurs when an individual is reasoning in hindsight about a less knowledgeable perspective (including one’s own less informed perspective), when reasoning about the current perspective of another individual, and when reasoning about how common knowledge is among a group of other people (Birch & Bloom, 2003; Birch & Bernstein, 2007).

The term ‘curse of knowledge’ was originally coined by economists Camerer, Lowenstein, and Weber (1989) who were interested in whether sales agents who were better informed about their products could be at a disadvantage based on their privileged information. Camerer et al. (1989) provided participants with a company’s earning from a ten-year period. Informed participants were also provided with the company’s earning for the following year. Uninformed participants were not given any further information. Both groups were asked to estimate what they thought others would predict as the company’s earning for the subsequent year. The results revealed that informed participants failed to fully ignore the privileged information that they received; that is, informed participants were ‘cursed’ by their knowledge, which interfered with their ability to accurately predict another’s perspective.

The curse of knowledge bias is a robust and widespread phenomenon that has been documented cross culturally (Heine & Lehman, 1996; Pohl, Bender, & Lachmann, 2002). The bias continues to persist after participants have been explicitly told to avoid it (Pohl & Hell, 1996), and remains prevalent despite educational instruction on the topic and cash incentives to avoid it (Camerer et al, 1989). The curse of knowledge bias has been examined through a host of
different experimental techniques within a variety of different domains, such as legal judgments (see, e.g., Kamin & Rachlinski, 1995; Rachlinski, 2000), medical diagnoses (see, e.g., Detmer, Fryback, & Gassner, 1978; Arkes, Wortman, Saville, & Harkness, 1981), sporting events (see, e.g., Leary, 1981), election results (see, e.g., Leary, 1982; Powell, 1988), labour disputes (see, e.g., Hawkins & Hastie, 1990; Mark & Mellor, 1991, for reviews), and conversational contexts (e.g., Keysar, 1994; Keysar & Blys, 1995). The curse of knowledge bias has received a variety of different names, depending on the discipline and context in which it manifests itself, including ‘creeping determinism’ (e.g., Fischhoff, 1975), ‘hindsight bias’ (e.g., Fischhoff, 1975; Bernstein & Harley, 2007), the ‘knew-it-all-along’ effect (e.g., Fischhoff, 1975; Wood, 1978), ‘the curse of expertise’ (e.g., Hinds, 1999), ‘adult egocentrism’ (e.g., Keysar, Lin, & Barr, 2003), ‘epistemic egocentrism’ (e.g., Royzman, Cassidy, & Baron, 2003), and ‘reality bias’ (e.g., Mitchell & Taylor, 1999). For simplicity, I will refer to the bias as the curse of knowledge throughout, and will discuss how the bias manifests itself in three different types of judgments.

At first glance, the curse of knowledge might appear to have a negative connotation as it constrains our ability to make accurate inferences about the perspectives of other individuals; however, the bias is believed to be a by-product of an otherwise adaptive learning system (Hoffrage, Hertwig, & Gigerenzer, 2000; Henriksen & Kaplan, 2003). That is, the curse of knowledge is a result of continuous updating that occurs to our knowledge structures when an individual acquires new information. Updating tends to occur so efficiently that it becomes challenging to disengage from the new information, even when one’s goal is to reason about a naïve perspective. That is to say, after learning new information one’s ability to imagine a perspective that lacked this information becomes limited. Although this routine updating worsens one’s perspective-taking abilities, it serves an adaptive function by keeping track of new events
and focusing our cognitive resources towards the most up-to-date information, which is critical for functioning in our rapidly changing everyday environments (Hoffrage, Hertwig & Gigerenzer, 2000).

The Curse of Knowledge Bias in Children and Adults

There is a wealth of psychological literature on the curse of knowledge in adults and its effects on different aspects of memory and social cognition (see Lilienfeld, Amirati, & Landfield, 2009; Roese & Vohs, 2012). Despite the extensive research on the curse of knowledge bias in adults, comparatively few studies within the developmental literature have examined this bias with children. However, research has shown that young children show this bias to a greater degree than older children and adults (e.g., Bernstein, Atance, Meltzoff, & Loftus, 2007; Birch & Bloom, 2003).

The curse of knowledge bias manifests itself in three types of erroneous judgments. First, the curse of knowledge bias can affect one’s memories of earlier events, and is sometimes referred to as ‘hindsight bias’ or the ‘knew it all along’ effect. Researchers have examined this first manifestation in both adults and children (discussed in the section entitled, Manifestation 1: Judgments of one’s earlier knowledge). Second, the curse of knowledge bias can influence a person’s ability to take on the perspective of another individual; that is, it may influence a person’s judgments of how easily a peer can solve a task or identify a particular object. Researchers have also examined this second manifestation in both adults and children (discussed in the section entitled, Manifestation 2: Judgments of another’s knowledge). Third, the curse of knowledge bias can affect one’s judgments of how common knowledge is among others or what a group of other individuals will think. To date researchers have only examined this manifestation in adults (discussed in the section entitled, Manifestation 3: Judgments of how
common knowledge is). The current study examines the third manifestation of the curse of knowledge bias in children’s judgments of how common knowledge is among their peers.

**Manifestation 1: Judgments of one’s earlier knowledge.** One commonly cited example of the curse of knowledge bias is cited in the work of Fischhoff and Beyth (1975). In this study participants were asked to predict the probability of a set of outcomes of Nixon’s future visit to the USSR (e.g., the USA and the USSR will agree to a joint space program). After learning the outcomes of Nixon’s visit, which involved several agreements with the USSR leader (including a joint space program), participants had to recall their earlier responses on the likelihood of the different outcomes. The results revealed that the participants’ knowledge of the actual outcomes of Nixon’s visit biased their memory of their prior estimates towards the actual outcomes of the event; that is, participants’ knowledge of the actual outcomes influenced how they remembered their prior estimates of the likelihood of the different outcomes.

A study by Taylor, Esbensen, and Bennett (1994) specifically examined the curse of knowledge bias and its influence on children’s judgments of how long they had known new information. In a series of four experiments researchers taught 4- and 5-year-old children novel facts (e.g., “What colour are tigers stripes?”), novel actions for familiar items (e.g., making a car go using orange juice) and unfamiliar items (e.g., make a gyroscope stand by itself), and new color words (e.g., chartreuse and taupe). Subsequently, children were asked how long they had known the new information. The results revealed that children tended to report knowing the new information for a long time; that is, children stated that they had known the information all along. It appears that 4-year-old children have a minimal awareness of learning new information and could not discriminate between information that was novel and information that was learned a
long time ago. As a result of being taught the novel actions and words, children became cursed by the knowledge and unable to recall their once more naïve perspective.

In an additional demonstration, Sutherland, Cimpian, Leslie, and Gelman (2015) presented 4- to 7-year-old children with generic facts (e.g., “Dogs get sick after eating carbamates”) and individual-specific facts (e.g., “Last night, this dog got sick after eating carbamates.”) in a series of four experiments. Children were then asked whether they had any prior knowledge of these facts. The results showed that children were more likely to think that they had ‘known-all-along’ the facts when the facts were about kinds (i.e., presented as generic statements) than when they were about individuals, when in reality they had just learned both. That is to say, the children in this study displayed a greater curse of knowledge bias for newly learned kind-relevant facts than for information that was true of a single individual. The researchers suggest that such errors demonstrate a fundamental feature of the human mind that privileges reasoning and learning about kinds (e.g., dogs) as opposed to individuals (e.g., a specific dog).

**Manifestation 2: Judgments of another’s knowledge.** To show young children’s greater susceptibility to the curse of knowledge bias Birch and Bloom (2003) investigated 3- to 5-year-olds ability to infer another’s knowledge regarding the contents of different containers when the children were either informed or uninformed as to the contents of the containers. In this study, children saw two sets of containers, one set which was familiar to the experimenter’s puppet friend Percy and the other set which was unfamiliar to Percy. On half of the trials children saw what was inside both sets of containers, whereas during the other half children did not see inside either set of containers. The results of this study demonstrated that when children knew the contents of the containers they overestimated what Percy would know; that is, they
were cursed by their knowledge. This tendency to be cursed by one’s own knowledge declined between 3 to 5 years of age.

A study by Bernstein, Atance, Loftus, & Meltzoff (2004) also found evidence in support of this manifestation of the curse of knowledge bias in children. In their visual perception design 3- to 5-year-old children and adults saw blurry images of common objects that gradually clarified on a screen. In the baseline condition participants identified images of common objects as they clarified on the screen. In the knowledge condition the common object clarified similarly to baseline except that prior to each clarification series a clear picture of each object was presented to the participants as a prime. Participants were then asked to imagine that a same-age peer (i.e., a puppet named Ernie) was seeing the object for the first time (i.e., they did not see the clear picture or prime first) and to stop the clarification series when they believed their peer would correctly identify the object. The results of this study demonstrated that child and adult participants who had previously seen the clear image of the common object overestimated how early Ernie would be able to identify the objects.

Additional research by Lagattuta, Sayfan, and Blattman (2010) demonstrated this manifestation of the curse of knowledge bias in both children (i.e., 4- to 9-year-olds) and adults. The goal of their study was to better understand children’s and adult’s ability to estimate a naïve individual’s perspective when interpreting pictures. In this design, participants were shown a series of pictures covered by a screen to reveal only a small, unidentifiable portion of the picture (e.g., part of a snail’s shell). Some participants saw the whole picture prior to it being covered by the screen, while other participants saw only the occluded portion. The results demonstrated that participants who saw the original picture prior to the test overestimated the likelihood that a naïve individual would correctly guess the picture’s identity, compared to those individuals who
only saw the occluded portion (also see Chandler & Helm, 1984; Taylor, 1988). Furthermore, children were more likely to be biased in their estimates compared to adults (also see Lagattuta, Sayfan, Blattman, 2010).

![Image](image.png)

(Lagattuta, Sayfan, and Blattman, 2010)

**Manifestation 3: Judgments of how common knowledge is.** A commonly cited example of the curse of knowledge bias is evident in the work of Fischhoff (1975), wherein adults who knew the results of a historical event thought naïve others would also predict that outcome. In this study participants were provided with a historical description of the British-Gurka war, with only some of the participants learning the actual outcome of the war. Subsequently, all participants had to consider several possible outcomes of the war, including the actual outcome, and then estimate how likely it would be for a naïve peer to predict the actual outcome. The results of the study found that adult participants who learned the outcome of the war overestimated the likelihood that naïve peers would also predict a similar outcome, compared to participants who did not learn the outcome of the war. The knowledge of the event outcome cursed participants’ abilities to reason and infer from a naïve perspective.

As mentioned previously, researchers have only examined **Manifestation 3: Judgments of how common knowledge is** in adults. One goal of the current study was to examine the third manifestation of the curse of knowledge bias in children’s judgments of how common knowledge is among their peers.
**Potential Mechanisms Underlying the Curse of Knowledge Bias**

Despite the abundance of evidence demonstrating the curse of knowledge bias across a wide variety of judgments, there is still relatively little known about the specific mechanisms that contribute to this bias. Several researchers have proposed a multitude of factors (or mechanisms) that may contribute to the curse of knowledge bias (e.g., Birch, 2005; Birch & Bernsteain, 2007; Nestler, Blank, & Egloff, 2010; Harley, Carlsen, & Loftus, 2004; Fischhoff, 1977; Sanna & Schwarz, 2004; Pohl, Eisenhauer, & Hardt, 2003 just to name a few; some of the factors that pertain to Manifestation 3: Judgments of how common knowledge is are discussed below and in the General Discussion). However, the exact nature of the mechanisms underlying the curse of knowledge bias is still a matter of immense interest and discussion (e.g., Groß & Bayen, 2015). Identification of the mechanisms underlying this bias will advance our understanding of how people reason about and infer the knowledge of others and will shed light on possible de-biasing techniques to reduce the curse of knowledge bias and foster more accurate perspective-taking. Thus far, de-biasing techniques have largely been unsuccessful or impractical (see, e.g., Sanna, Schwarz, and Small, 2002; Camerer et al, 1989). Gaining more insight into the specific mechanisms that underlie the curse of knowledge bias may help identify more effective ways to de-bias the curse of knowledge, which should in turn result in corresponding improvements in other facets of social competence.

**An inhibitory control mechanism.** One proposed mechanism underlying the curse of knowledge bias is inhibitory control. Explanations that involve inhibition argue that people have difficulty fully discounting or inhibiting their own knowledge. For example, when people are asked trivia questions such as “Who invented the TV?” and are asked to estimate the percentage of peers who would know the answer to this question, those who know the answer (i.e.,
Farnsworth and Jenkins) overestimate the percentage of peers who will also know the answer compared to those people who do not know. Under the inhibitory control account it is the difficulty with inhibiting or suppressing the privileged content of one’s own knowledge that results in the curse of knowledge bias. That is, individuals who know who invented the TV are not able to completely ignore this information when trying to reason and infer from a naïve perspective, or when recalling their own earlier perspective. A strength of an inhibitory account is its potential to explain the U-shaped pattern of age-related changes, whereby the degree of the curse of knowledge bias is greatest for young children and aging adults (Groß & Bayen, 2015; Bernstein et al., 2011; Bayen et al., 2007). The inverted U-shaped developmental pattern is in line with the fact that inhibitory processes are tied with frontal lobe development (which is involved in inhibition), and the frontal lobes are the last part of the brain to develop when children are young and the first part of the brain to deteriorate in older adults (Dempster & Corkhill, 1999).

An inhibitory control mechanism is at least consistent with age related changes revealed in research by Diamond and Taylor (1996) who looked at executive functioning capabilities in children ages 3 ½ to 7 years. In this study children were given the following two rules: immediately after the experimenter tapped once with a wooden dowel the child was to tap twice with the dowel; and immediately after the experimenter tapped twice, the child was to tap once. The results of this study revealed that children improved with age in both their accuracy and speed on the tapping task, with the most improvement occurring in 6-year-olds. With age, children improved in their ability to inhibit what was automatic to them, to play by a new rule; that is to say, important inhibitory control abilities appeared to be occurring some time between 3 to 7 years of age, and this improvement may reflect important changes within frontal cortex
development (see also, e.g., Hala, Hug, and Henderson, 2003).

Research by Bernstein, Atance, Loftus, & Meltzoff (2007) sought to better understand the link between theory of mind, hindsight bias, and inhibitory control. In their research 3- to 5-year-old children saw blurry images of common objects that gradually clarified using a procedure similar to that outlined on page 13 (see Bernstein, Atance, Loftus, & Meltzoff, 2004). In the baseline condition, participants identified images of common objects as they clarified on a screen. In the hindsight condition, the common object was clarified similarly to the baseline condition, except that prior to each clarification series a clear picture of each object was presented to the participants as a prime. Participants were asked to stop the clarification series when they believed a peer would correctly identify the image. Subsequently, participants completed a series of theory of mind tasks. In all but one of the theory of mind tasks children were asked about their own prior belief and about the beliefs of a naïve same-aged peer (i.e., a puppet named Ellie). Children in both experiments also participated in two inhibitory control tasks. The results across two experiments revealed a robust hindsight bias effect, and a correlation between children’s performance on the hindsight bias tasks and their performance on theory of mind tasks; that is, the greater one’s hindsight bias the worse one’s theory of mind performance. However, unlike what is predicted by the inhibitory control account, the results of this study revealed that inhibitory control did not mediate the relation between hindsight bias and theory of mind; although, it is possible that inhibitory control could still be a contributor to the curse of knowledge bias. Therefore, although there is research supporting an inhibitory account as an explanation for the curse of knowledge bias (Coolin, Erdfelder, Berstein, Thornton, & Thornton, 2015; Groß & Bayen, 2015), age differences in inhibitory function may not fully account for the age differences seen in the bias (see Bayen, Pohl, Erdfelder, & Auer, 2007 for a
review of the strengths and weaknesses of inhibition accounts). That is, it is probable that more than one mechanism is involved in the cure of knowledge bias.

**A fluency misattribution mechanism.** Fluency misattribution has been proposed as another potential mechanism behind the curse of knowledge bias (Harley, Carlsen, & Loftus, 2004). Fluency misattribution argues that the subjective feeling of ‘fluency’ associated with familiar, or easy-to-process, information becomes misattributed as the information being objectively easy or obvious to others. In this account it is not a difficulty with inhibiting the content of the knowledge per se that leads to the bias, but rather it is the fluency with which that content comes to mind (or the accessibility of the information in mind) that gets misattributed to the information being easier or more obvious to others. For example, when people are asked trivia questions such as “Who invented the TV?” and are asked to estimate the percentage of peers who will know the answer to this question, those who know the answer overestimate the percentage of peers who will also know; this difference is the curse of knowledge bias.

According to a fluency misattribution account it is not a difficulty discounting the content of the knowledge that results in the bias but rather it is the fluency with which the content comes to mind (or the feelings of familiarity or fluency associated with the information) that gets misattributed to the information being available to others.

Fluency misattribution accounts have been offered as explanations for a range of biases in judgments. The common idea behind all of the fluency misattribution accounts is that when any part of one’s processing of a stimulus is fluent, there is the possibility that a person can misattribute the source of that fluency. For example, the feelings of fluency associated with easy stimulus processing may allow participants to conclude that they like the fluently processed stimulus more than a less fluently processed stimulus (i.e., when fluency misattribution
contributes to liking judgments it is known as the mere exposure effect; Fang, Singh, Ahluwalia, 2007; Zajonc, 1968).

A demonstration of the fluency misattribution account is shown in the research of Song and Schwarz (2008). In a series of three experiments the researchers gave participants instructions for an exercise routine and subsequently a food recipe printed in either an easy-to-read (i.e., Arial, 12 point) or a difficult-to-read (i.e., Brush, Mistral, 12 point) font. Participants were then asked to estimate the time that it would take to complete the activity on a 7-point scale. The results of this study demonstrated that participants misattributed the ease of processing the instructions as indicative of the ease with which certain tasks would be completed; that is to say, that the task would require more skill and time, and be less engaging when printed in a difficult-to-read font.

Taken together, the aforementioned results demonstrate how people rely on their metacognitive (i.e., awareness of one’s own memory capabilities) experiences when making any number of different judgments. In fact, fluency misattribution has been shown to influence judgments when considering stimuli’s clarity, duration, truth-value, and level of fame (e.g., Jacoby, Woloshyn, & Kelley, 1989; Bernstein, Whittlesea, & Loftus, 2002; Brinol, Petty, & Tormala, 2006; Unkelbach, 2006; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). What these data suggests is that people are being influenced by the fluency of their information processing experiences as a factor in making a variety of cognitive, perceptual, and affective judgments.

Importantly, fluency misattribution appears to be a type of source misattribution or source monitoring error. Source monitoring entails the ability to recall the source of one’s knowledge and beliefs. It is an important cognitive skill that allows children to make accurate
decisions about their memories for sources (Johnson, Hashtroudi, & Lindsay, 1993). For example, whether a child believes they have actually done their homework, or only imagined they had is an instance of source monitoring (Roberts & Blades, 2000). Ultimately, source monitoring successes and failures colour one’s memory for events and influence how one’s beliefs and knowledge are expressed (Johnson et al, 1993). Source monitoring is a cognitive skill that begins to emerge as early as 2 ½ years of age, with steady improvement seen throughout childhood and adolescence (Hala, Brown, McKay, & San Juan, 2013; Roberts & Blades, 2000).

Research by Jacoby, Kelley, Brown, and Jasechko (1989) demonstrates how, fluency misattribution is the result of a source monitoring error. In this classic study, researchers presented participants with names and informed them that the names belonged to people who were not famous. Subsequently, in the test phase participants received these same old names together with new names and were asked to judge the level of fame for both the old and new names. The results demonstrated that when the test phase followed a 24-hour delay the participants were more likely to judge the old names as famous compared to the new names. In contrast, when the test phase immediately followed the presentation the old names were less likely to be called famous than were the new names. The researchers suggest that after a 24-hour delay the old names were processed as being more famous because the increased processing fluency was experienced as a feeling that can be readily attributed to familiarity. Conversely, when the test phase immediately followed baseline participants did not attribute this feeling of familiarity to the fame of the names, because they recognized its source (i.e., their prior in lab exposure to the names). What this suggests is that in adults you see the effects of fluency misattribution if the source of the fluency is forgotten or not recognized (source monitoring error). Given that children are notorious for poor source monitoring, I hypothesize that they will
be more prone to fluency misattribution; children do not yet have the source monitoring capabilities to adequately recognize the source of their fluency making them more susceptible to misattribution errors.

A previous study by Gopnik and Graf (1988) exemplifies how young children have difficulties in identifying the source of their knowledge. In this study children were shown an array of six drawers. Children were individually shown the contents of two of the drawers, whereas in four cases children were either told what was inside or were given a clue (i.e., a crayon box) and asked to guess the contents of the drawer. Children were then asked to identify how they knew about the object in each drawer (e.g., a dinosaur) through a force-choice source monitoring question with three different options (i.e., saw it yourself, told by the experimenter, or inferred it from a clue). The results of this study revealed that 3-year-olds have difficulty identifying the source of their knowledge, and children maintained this difficulty after explicit instructions and training in identifying sources. These data are also consistent with the age related reduction in the curse of knowledge bias observed in the preschool period (e.g., Birch & Bloom, 2003).

To date the only published literature examining the role of fluency misattribution in the curse of knowledge (or hindsight) bias comes from Harley, Carlsen and Loftus (2004; Exp. 3) using a visual perception task similar to that described earlier on pages 13 and 17 (see Bernstein, Atance, Loftus, & Meltzoff, 2004; 2007). This design is similar except that in the baseline condition participants had to identify celebrity faces on a computer screen that began blurry and then gradually became clearer. Subsequently, participants completed the hindsight condition whereby they viewed some of the baseline faces (i.e., old faces) as well as new celebrity faces, and estimated the blur level at which a naïve peer would be able to identify each face. In the
hindsight condition, faces clarified similarly to baseline except that prior to each clarification series a clear picture of each celebrity face was presented to the participants as a prime. Participants were then asked to imagine that a same-age peer was seeing the face for the first time (i.e., they did not see the clear picture or prime first) and were asked to stop the clarification series when they believed their peer would correctly identify the face. The results demonstrated that participants believed that their peers would identify the faces at a more degraded point than they were able to at baseline, and, importantly, this effect was greater for old faces than for new faces. The findings of Harley et al. (2004) suggest that perceptual items (i.e., images of celebrity faces) presented repeatedly (i.e., old faces) resulted in more biased estimates of how easily a peer could recognize those faces; that is, the curse of knowledge bias was greater for more frequent or fluently-processed perceptual items (also see Bernstein & Harley, 2007).

*Baseline Condition*

*Hindsight Condition*

*New Faces*  
unfiltered  
$f_1 = 5.16$  
$f_1 = 9.90$  
$f_1 = 14.63$  
$f_1 = 20.66$  
unfiltered  

*Old Faces*  
unfiltered  
$f_1 = 5.16$  
$f_1 = 9.90$  
$f_1 = 14.63$  
$f_1 = 20.66$  
unfiltered

(Harley, Carlsen, & Loftus, 2004).
A post-hoc assessment of a finding from a study by Fussell and Krauss (1992; Exp 3) seems consistent with a fluency misattribution account of the curse of knowledge bias. In this study undergraduate students were presented with a series of black and white line drawings of an assortment of objects (e.g., sporting equipment, household appliances, car parts), and then asked if they knew the name of the object and rated their ‘feelings of knowing’ on an 8-point scale. Participants were then asked to estimate the percentage of students who would also know the answer to each of the questions (i.e., peer estimates). The results of this study revealed that feelings of knowing correlated with participant’s estimates of their peer’s knowledge; that is, when participants had strong feelings of knowing they estimated that a high percentage of peers would also know the answer (see also, Nickerson, Baddeley, & Freeman, 1987). The curse of knowledge bias occurred even in the absence of explicit content knowledge, suggesting that familiarity alone can trigger the bias. Still, one should be cautious when interpreting the abovementioned finding because it is possible that this correlation simply reflects naturally occurring differences in the items (e.g., item difficulty) or individual differences in one’s tendency to experience feelings of knowing and one’s susceptibility to the curse of knowledge bias. One major limitation of this study is that the researchers did not test to see how widely known the objects really were (i.e., what their peers actually knew), so there is not a way to rule out that the feelings of knowing were associated with how easy or hard the question really was. It may be the case that easier items were indeed known by more of their peers and may not have related to the curse of knowledge bias at all.

In summary, to date little research has examined the important role of fluency misattribution in social perspective-taking leaving critical gaps in the current literature: the effect of fluency misattribution on the curse of knowledge bias in people’s judgments of how widely
known facts are, and the role of fluency misattribution in young children’s ability to reason about what others know. On the former, preliminary research (Birch, Brosseau-Liard, Bernstein, Haddock, & Ghrear, under review) provides initial evidence that fluency misattribution contributes to the curse of knowledge bias in adults. In this experiment adult participants were presented with one of three lists of trivia questions (e.g., “Who invented the TV?”) and asked to learn the answers (Known Items). Participants were then presented with a second list and asked if they knew the answers to the questions, but were not taught the answers (Fluent Items; i.e., no content knowledge to inhibit). To increase the feelings of fluency for these items participants were presented with each of the items three times. One-week later participants were presented with the items from the Known and Fluent lists as well as items from a third (New) list. For all items they were asked if they knew the answer to each of the questions and were also asked to estimate their peers’ knowledge of the answers (i.e., “What percentage of other psychology students in this study will know the answer to this question?”). The results of the study revealed that both knowledge content and fluency significantly contributed to the curse of knowledge bias. That is, trivia questions that were taught (Known) led to judgments that those questions were more widely known than questions that were not taught (New). Trivia questions shown repeatedly (Fluent) led to judgments that those questions were more widely known than questions shown only once (New). In other words, even though the answers to the Fluent items were not known (i.e., there is no content to inhibit) simply making the question more fluent, via repeated exposure, led participants to judge that others would be more likely to know the answers to those questions compared to questions that were less familiar to the participants.

**Current Study, Hypotheses, and Research Questions**
My master’s thesis aimed to better understand the effect of fluency misattribution on the curse of knowledge bias by expanding upon my earlier work with adults described above (Birch et al., under review) to examine whether manipulating the frequency of the information presented would influence children’s judgments of how common that knowledge is among their peers. In addition, I wanted to compare the relationship between children’s fluency misattribution and their performance on curse of knowledge and source monitoring tasks.

In the current within-subjects design children aged four to seven were read, out loud by the experimenter, a series of four short stories about two different groups of animals (e.g., a group of hippos and a group of giraffes). One group of animals was made more frequent by repeatedly mentioning that group in the story. After each story participants were then asked to predict whether “more kids will know what a group of hippos is called or what a group of giraffes is called?” Based on previous research I hypothesized: 1) that the frequency of information would lead children to misattribute how common knowledge is among others; that is, children who heard items repeatedly (high fluency) would estimate that the knowledge is more common compared to those who have heard items only once (low fluency); and 2) that the impact of fluency misattribution would decline with age.

Subsequently, children participated in a curse of knowledge task. In this task the experimenter read children another four stories about two different groups of animals (e.g., a group of leopards and a group of zebras); however, children were only taught a fact about one group of animals (e.g., a group of zebras is called a dazzle). Participants were then asked to predict whether “more kids will know what a group of leopards is called or what a group of zebras is called?” I hypothesized a replication of the curse of knowledge bias and its age effect
(i.e., declines with age), but for the first time showing its affect on children’s judgments of how common knowledge is.

Finally, children were asked a series questions about when they had learned certain facts to assess the impact of the curse of knowledge on children’s source monitoring capabilities. Here, they were asked whether they ‘knew before today’ the facts that they were just taught in the curse of knowledge task above, and for comparison, facts they had known for a long time (e.g., fish live in the water). I hypothesized that source monitoring capabilities would improve with age. I also hypothesized that there would be an overall correlation between children’s performance across the three tasks such that, as children get older fluency misattribution and the curse of knowledge bias would decrease, while source monitoring abilities would increase. I also anticipated that the relationship between source monitoring and fluency misattribution would hold even when controlling for the effects of age because individual differences in one’s source monitoring abilities should predict how susceptible one would be to fluency misattribution.

In sum, my primary research questions for the current design were: 1) Does manipulating the frequency of information lead children to misattribute how common knowledge is among others?, 2) What are the effects of age on fluency misattribution?, 3) What are the effects of age on the curse of knowledge bias when judging how common knowledge is among one’s peers?, 4) What are the effects of age on source monitoring capabilities?, and 5) What are the relationships across the three tasks (i.e., the fluency task, curse of knowledge task, and source monitoring task)?
Method

Participants

A sample of 129 4- to 7-year-old participants was recruited for this study. Fourteen children had to be excluded from the analyses for the following reasons: 6 children were removed due to experimenter error (e.g., failure to follow the correct procedure), and 8 children (i.e., 4 4-year-olds, 1 5-year-old, and 3 6-year-olds) failed to complete at least the first of the 3 tasks in the experiment, which was likely due to boredom and/or fatigue. As a result, the final sample consisted of 115 children (63 male, 45 female): Fifty-one 4-year-olds (M = 53.53; SD = 3.42; Range = 48 – 59 months), 30 5-year-olds (M = 64.67; SD = 4.83; Range = 50 – 71 months), and 34 6- to 7-year-olds (M = 80.35; SD = 5.70; Range = 72 – 95 months). Based on parental reports of children’s ethnicity, 42 were identified as Caucasian, 38 as Asian, 24 as mixed ethnicity, and 5 as ‘other’ (unspecified). All the child participants were recruited through preschool programs, schools, and childcare facilities in Vancouver, BC, as well as through the UBC Early Development Research Group and the Living Lab at Telus World of Science. The current study also met the ethical standards of the British Columbia Research and Ethics Board certificate number: H12-03323. Informed consent was obtained from the school or the childcare facility, as well as the parents of each prospective participant. Prior to testing, informed assent was obtained from each of the children. All parents were aware that participation was voluntary. Children received a t-shirt, book, or stickers as a token of appreciation for their participation in the study. Participating childcare facilities and schools received a $25 gift certificate for educational materials.

Materials

The materials needed for this task consisted of a total of 14 pictures. Among the 14
pictures, 4 pictures were used for the practice phase, 2 pictures with stick figures were used
during the training and test portions, and 8 pictures of different groups of animals were used for
the fluency task (see Appendix A for pictures).

**Procedure**

All children were individually tested. Children were seated next to the experimenter, with
testing materials set up on a table in advance. Testing took approximately 15 to 25 minutes
depending on the age of the participant. Each child was given an opportunity to get comfortable
with both the experimenter and the surrounding environment prior to testing. All children
participated in all the tasks in a constant order.

**Fluency practice phase.** The experimenter administered a total of three practice
questions. First children were shown two pictures, one with 7 stick figures and the other with 2
stick figures and then asked, “Which picture has more kids?” The purpose of this question was to
ensure that children had an understanding of the meaning of the word ‘more’. An understanding
of the word ‘more’ was a necessary requirement for children on subsequent sections of the
current procedure, and was intended for use as exclusion criteria. That is, children who failed the
initial training question or needed prompting in order to successfully answer the question would
be excluded from the final analyses. However, 100% of the participants answered this question
correctly. For the remaining two training questions only the picture of 7 stick figures remained
present along with the additional training pictures. For the second practice question children
were asked, “Do more kids like to eat fruit or bugs?” For the third practice question children
were asked, “Will more kids know that a group of birds is called a flock or that a group of
camels is called a caravan?” These questions were included to introduce children to the force-
choice question format, “Will more kids know X or X?”, and ultimately familiarize them with
our test question format, “Will more kids know what a group of X is called or what a group of X is called?” used in the subsequent tasks, but were not used as exclusion criteria; 98% of participants chose fruit over bugs and 72% chose flock of birds over a caravan of camels (for the full experimental script refer to Appendix B).

**Fluency task.** During this part of the task the experimenter read a series of four short stories about different groups of animals out loud to each of the participants. Note that for the current design I manipulated the frequency of information, assuming that the increased frequency of the information would lead to an increase in fluency, and ultimately fluency misattribution given children’s poor source monitoring abilities. Within each story children heard about two different groups of animals. One group of animals was made highly frequent; children heard a critical phrase six times (e.g., a group of hippos), whereas participants heard the critical phrase only once (e.g., a group of giraffes) for the other group (the low frequency items). That is, the fluency manipulation was whether children heard the phrase frequently throughout a given story, or only once. The question order (i.e., which group of animals was asked first in the test question) and the animal set (i.e., which group of animals were presented more frequently) were counterbalanced across participants. An example of one fluency story is described below:

“This is a story about Bruce and his visit to a safari exhibit. Bruce walked around visiting all the animals at the safari exhibit. The first animals Bruce saw were a group of hippos. It was early in the afternoon when Bruce saw the group of hippos playing in the water of a nearby swamp. The group of hippos was enjoying a game of hide-and-seek. It took a long time for the group of hippos to find one another hidden amongst all the murky water and plants of the swamp. As evening drew near the group of hippos grew hungry and left the swamp in search of some food. They eventually found a nice field of
grass to eat for dinner. After dinner was through the group of hippos spent the evening talking and relaxing under the stars about their afternoon of fun. The second animals Bruce saw were a group of giraffes. Bruce had a great day visiting the animals at a safari exhibit.”

The experimenter then referred to two animal pictures based on the corresponding story placed in front of the child in advance along with the pictures of the 7 stick figures and 2 stick figures (see Appendix C for an example of the test set up). The experimenter then asked the participant to guess which group of animals more children would know about. For example, “Will more kids know what a group of hippos is called or what a group of giraffes is called?” The procedure mentioned above was repeated in the same manner for three additional stories (for the full experimental script refer to Appendix B).

Curse of knowledge task. In this task children were again read four different stories about two different groups of animals out loud by the experimenter (e.g., a group of leopards and a group of zebras). However within this task, children were taught a fact about one group of animals (e.g., a group of zebras is called a dazzle) but not the other. In this task there were no pictures of groups of animals to eliminate any concern that the pictures could introduce feeling of fluency. Children responded verbally. The question order (i.e., which group of animals was asked first in the test question) and taught set (i.e., which group of animals was taught) were counterbalanced across participants. Here is an example of one of the curse of knowledge stories:

“This is a story about Ben and his visit to Africa. Ben visited all the animals that lived in Africa. The first animals Ben saw were a group of leopards. The second animals Ben saw were a group of zebras. A group of zebras is called a dazzle. Can you say that? A dazzle? That’s right! Ben had a great time visiting all the animals that lived in Africa.”
The experimenter then referred to the pictures of the 7 stick figures and 2 stick figures and asked participants to guess which group of animals more children would know about. For example, “Will more kids know what a group of zebras is called or what a group of leopards is called?” The procedure mentioned above was repeated in the same manner for three additional stories (for the full experimental script refer to Appendix B).

**Source monitoring task.** Subsequently, all child participants were asked a series of eight Yes/No source monitoring questions (using a procedure employed by Taylor, Esbensen, & Bennett, 1994; Exp 3). Four were considered ‘old’ questions that participants knew the answer to prior to their participation in the study (e.g., “Did you know that fish live in the water before today?”). Four of the questions were ‘new’ questions that participants were taught during their participation in the study (e.g., “Did you know a group of zebras is called a dazzle before today?”). The taught set (i.e., which group of animals was taught) was counterbalanced across participants (for the full experimental script refer to Appendix B).
Results and Discussion

Fluency Task

For the fluency task, the primary independent variable was whether children heard the information frequently throughout the stories (i.e., 6 times) or only once. The primary dependent variable was the number of times out of 4 that children chose the groups of animals that were presented frequently (referred to as the High Fluency items). A one-sample t-test was conducted to determine if children were more likely than chance to choose the High Fluency groups of animals. As predicted, children were more likely than chance to choose the groups of animals that were presented most frequently as being more widely known ($M = 2.20; SD = .99$), $t(114) = 2.16$, $p = .033$, 95% CI [0.02, 0.38], $d = 0.405$. I also conducted an item analysis looking at the results for each question (refer to Table 1 on page 73).¹

To determine if there were any effects of order, gender, or age I conducted a 2 (question order) x 2 (animal set) x 2 (gender) x 3 (age) univariate ANOVA with age group (i.e., 4s, 5s, and 6/7s), question order (i.e., which group of animals was asked first in the test question), animal set (i.e., which group of animals were presented more frequently), and gender as between-subject factors using the total number of times children chose the High Fluency items as the dependent variable. The ANOVA revealed no main effects or interactions all $ps > .10$, except for a theoretically uninteresting and potentially spurious 4-way interaction between all four variables, $F(2, 91) = 3.22$, $p = .045$, partial $\eta^2 = .066$. Contrary to my hypothesis that older children would be less susceptible to fluency misattribution when judging what others know, there was no effect of age, $F(2, 91) = 0.005$, $p = .996$. A correlation between age in months and children’s

¹ Note that the order of the items (i.e., test questions) was held constant in each task so it is impossible to determine if the differences observed by question reflect the nature of the question itself or the order of that question.
propensity to choose the High Fluency items further demonstrated that fluency misattribution did not vary as a function of age, $r(115) = .01, p = .88$.

Nonetheless, given my a priori hypothesis that fluency misattribution would vary as a function of age, I conducted three one-sample t-tests (one for each age group) comparing their likelihood to choose the High Fluency items with chance. Even without Bonferroni correction for multiple tests, no age group’s likelihood of choosing the High Fluency items was significantly above chance on its own: 4-year-olds ($M = 2.22; SD = 1.06$), $t(50) = 1.45, p = .15$, 95% CI [-0.08, 0.52]; 5-year-olds ($M = 2.13; SD = 0.73$), $t(29) = 1.00, p = .33$, 95% CI [-0.14, 0.41]; and 6- and 7-year-olds ($M = 2.24; SD = 1.10$), $t(33) = 1.24, p = .22$, 95% CI [-0.15, 0.62]. These results further illustrate that although the frequency with which the items were presented affects children’s judgments of what others know, the magnitude of that effect in my design was on the small side, small to moderate (i.e., $d = 0.405$).
Figure 1. Mean number of times children chose the High Fluency versus Low Fluency items by age group. Error bars represent the standard error of the mean.

Curse of Knowledge Task

For the curse of knowledge task, the primary independent variable was whether children were taught the items (e.g., a group of zebras is called a dazzle) or not. The primary dependent variable was the number of times out of 4 that children chose the items that they were taught the answers to (referred to as the Taught items) as being more widely known by their peers. To test whether children, overall, were more likely than chance to choose the Taught items as more widely known I conducted a one-sample t-test. The t-test revealed that overall children chose the Taught items more often than chance ($M = 2.32; SD = 1.23$), $t(114) = 2.80, p = .006$, 95% CI [0.09, 0.55], $d = 0.524$. (refer to Table 1 on page 73 for a breakdown by item).

To determine if there were any effects of order, gender, or age I conducted a 2 (question order) x 2 (taught set) x 2 (gender) x 3 (age) univariate ANOVA with age group (i.e., 4s, 5s, and 6 to 7s), question order (i.e., which group of animals was asked first in the test question), taught set (i.e., which group of animals was taught), and gender as between-subject factors using the total number of times children chose the Taught items as the dependent variable. The ANOVA revealed no main effects or interactions, all $ps > .10$, including no main effect of age, $F(2, 91) = 7.68, p = .346$, partial $\eta^2 = .958$. The results of this ANOVA are contrary to my hypothesis, and previous literature showing a reduction in the magnitude of the curse of knowledge bias with age.

Given my a priori hypotheses that the curse of knowledge would vary as a function of age, I conducted three one-sample t-tests (one for each age group) comparing their likelihood to choose the Taught items with chance. Applying Bonferroni correction for multiple tests
(Bonferroni-adjusted alpha = .017), only the oldest age group was significantly above chance on its own: 4-year-olds ($M = 2.06; SD = 1.29$), $t(50) = 0.33$, $p = .77$, 95% CI [-0.30, 0.42]; 5-year-olds ($M = 2.30; SD = 1.32$), $t(29) = 1.25$, $p = .22$, 95% CI [-0.19, 0.79]; and 6- and 7-year-olds ($M = 2.74; SD = 0.96$), $t(33) = 4.45$, $p = .00$, 95% CI [0.40, 1.07], $d = 1.55$. A further analysis revealed that there was a significant correlation by age in months, $r(115) = .244$, $p = .008$, in a direction contrary to my hypothesis. This result is surprising considering the vast amount of literature on the curse of knowledge suggesting that the bias is greater for younger children than it is for older children and adults (e.g., Bernstein, Atance, Meltzoff, & Loftus, 2007; Birch & Bloom, 2003).

The current finding reveals that the 6- and 7-year-old children displayed a greater curse of knowledge bias than either the 4- or 5-year-olds participants. I suspect that much of this difference is due to the placement of the curse of knowledge task within my design. Currently the curse of knowledge task comes after the fluency task making it possible that the younger participants were more fatigued and less attentive to the stories by the time they reached this task. As well, both the fluency and curse of knowledge tasks have a lot of verbal information that children must pay attention to in order to respond accurately; however, unlike the fluency task there were no pictures of different group of animals to help the children to remain focused during the curse of knowledge task. Perhaps the additional verbal information without the use of pictures placed too many cognitive demands on the already fatiguing 4- and 5-year-old participants, eliminating my ability to detect the curse of knowledge bias. Conversely, the 6- and 7-year-olds may have been more equipped to handle the additional verbal information and cognitive load of the stories (without the use of pictures), allowing me to observe the expected effect. Anecdotally, I also noticed that the younger children were more apt to make idiosyncratic
comments such as “I like giraffes because they are tall” or “I saw leopards at the zoo” in response to the test questions than the older children whose answers appeared more ‘on task’.

On the other hand, the result may reflect a genuine difference in the role that the curse of knowledge plays in children’s judgments of how common knowledge is among a group of others across development (compared to developmental changes previously observed in the other two manifestations of the curse of knowledge). Importantly, recall that this is the first experiment to examine the curse of knowledge in children’s judgments of how widely known information is among one’s peers. It may be the case that reasoning about how prevalent knowledge is amongst a group of people is harder for young children than reasoning about the knowledge states of a single individual.

Figure 2. Mean number of times chose the Taught items by age group. Error bars represent the standard error of the mean.

Source Monitoring Task

For the source monitoring task, the primary independent variable was whether children
were asked about the source of their memory for items that were Old (e.g., “Did you know that fish live in the water before today?”) versus New (e.g., “Did you know that a group of zebras is called a dazzle before today?”). The primary dependent variables were the number of times out of 4 that children said ‘yes’ for the Old items, and the number of times out of 4 that children said ‘yes’ for the New items. I conducted a 2 (question order) x 2 (question type: Old and New) x 2 (gender) x 3 (age) repeated measures ANOVA with age group (i.e., 4s, 5s, and 6 to 7s), taught set (i.e., which group of animals was taught), and gender as between-subject factors and question type as a within-subjects factor. The ANOVA revealed that there was no main effect of gender, or taught set, or any interactions with gender or taught set, all ps > .10. As predicted there was a main effect of question type (Old versus New), revealing that overall children were less likely to say they knew the New items before today ($M = 2.21$, $SD = 0.17$) than the Old items ($M = 3.59$, $SD = 0.08$), $F(1, 103) = 78.95$, $p < .001$, partial $\eta^2 = .434$. Importantly, as predicted there was a significant interaction between age and question type, $F(2, 103) = 5.748$, $p = .004$, partial $\eta^2 = .100$, revealing that children’s ability to differentiate between Old and New items varied as a function of age (refer to Table 1 on page 73 for a breakdown by item).

Given my a priori hypothesis that children’s source memory abilities would vary as a function of age I conducted six one-sample t-tests (two for each age group separately) comparing their tendency to say they knew ‘before today’ the Old and New items (separately) to chance (using the Bonferroni-adjusted alpha =.008). First, I report children’s ability to recognize that they knew the Old items before today. All three age groups were significantly more likely than chance to indicate they knew the Old items before today: 4-year-olds ($M = 3.71$, $SD = 0.73$), $t(50) = 16.71$, $p < .001$, 95% CI [1.50, 1.91], $d = 4.73$; 5-year-olds ($M = 3.43$, $SD = 0.94$), $t(29)$ =
8.39, \( p < .001 \), 95% CI [1.08, 1.78], \( d = 3.12 \); and 6- and 7-year-olds (\( M = 3.62, SD = 0.82 \), \( t(33) = 11.55, p < .001 \), 95% CI [1.33, 1.90], \( d = 4.02 \).

Next, I report children’s ability to recognize that they did not know the New items before today. The 4-year-olds were significantly above chance (\( M = 2.80, SD = 1.67 \), \( t(50) = 3.43, p = .001 \), 95% CI [0.33, 1.27], \( d = 0.97 \), suggesting not only an inability to accurately judge when they acquired the information they were just taught minutes ago but a significant ‘curse of knowledge’ or ‘knew-it-all-long’ effect. No other age groups displayed significant results: 5-year-olds (\( M = 2.10, SD = 1.73 \), \( t(29) = 0.32, p = .754 \), 95% CI [-0.55, 0.75]); and 6- and 7-year-olds (\( M = 1.53, SD = 1.67 \), \( t(33) = -1.64, p = .111 \), 95% CI [-1.05, 0.11]). It is important to note, however, that all of the source monitoring results should be interpreted with some caution as they could also be due to a bias to say ‘yes’ to yes-no style questions or an unwillingness to acknowledge their earlier ignorance (e.g., a desire to appear knowledgeable).
Figure 3. Mean number of times children said ‘yes’ to the Old items versus the New items by age group. Error bars represent the standard error of the mean.

To better capture children’s ability to differentiate between the Old and New items and to control for within-subject variability in children’s performance (which may include a greater tendency for some individuals to say ‘yes’), I computed the difference scores between Old and New items. Using this difference score as the dependent variable I conducted a univariate ANOVA with age, again revealing that children become better with age at differentiating between newly-acquired knowledge and knowledge they have possessed for a longer period of time, \( F(2, 112) = 5.92, p = .004 \), partial \( \eta^2 = .096 \). Tukey post-hoc tests (Bonferroni-adjusted alpha \( = .017 \)) revealed that the only significant difference in performance was between the 4-year-olds \( (M = 0.90, SD = 1.52) \) and the 6- and 7-year-old group \( (M = 2.08, SD = 1.62) \), \( p = .002 \). The 5-year-olds \( (M = 1.33; SD = 1.54) \) were not significantly different from either group, \( p > .10 \). A further analysis using the difference scores revealed that there was a significant correlation between age in months and children’s ability to differentiate Old and New items, \( r(115) = .27, p = .003 \). In sum, as originally predicted, children’s ability to accurately recall when they acquired new information and their ability to differentiate between information they have known for awhile from information learned minutes earlier significantly improves between four and seven years of age.

Relationships Between the Three Tasks

To determine whether children’s performance across the three separate tasks was correlated, above and beyond the effects of age, I conducted partial correlations using the following three dependent variables: 1) their tendency to choose the High Fluency items in the fluency task; 2) their tendency to choose the Taught items in the curse of knowledge task; and 3)
the difference scores between the Old and New items in the source monitoring task. Contrary to my hypothesis, the results revealed that children’s performance on the curse of knowledge task was not correlated with performance on the fluency task, \( r(112) = -0.08, p = .395 \), nor the source monitoring task, \( r(112) = .035, p = .713 \). I believe that children’s curse of knowledge score did not correlate with their source monitoring or fluency performance because of the aforementioned limitations in the curse of knowledge task. Moreover, I suspect that children’s performance on the curse of knowledge task did not correlate with their performance on the fluency task because the two tasks appear to be tapping two different mechanisms that influence people judgments of what others know (a point that I will return to in greater detail in the General Discussion section of this paper).

As expected, however, children’s performance on the fluency task was correlated with their performance on the source monitoring task, \( r(112) = -.17, p = .035 \), one-tailed, revealing that fluency misattribution decreased as source monitoring capabilities increased, over and above the effects of age. These findings suggest that as source monitoring capabilities improve the impact of fluency will decline. Recall from my aforementioned discussion on fluency misattribution in the adult literature that you do not see the effects of fluency when participants are able to recall the source; this same logic is likely to apply with children. However, children as a whole are not good at recalling the source of knowledge acquired only minutes ago, which is likely to make them more susceptible to fluency misattribution than adults. Therefore, it is not surprising that individual difference in their source monitoring performance predicted their susceptibility to fluency misattribution. What is interesting to note is that the New source monitoring items were from the curse of knowledge task, and thus represent individual
differences in source monitoring abilities more generally not their memory for the items in the fluency task (which in fact they did not learn).
General Discussion

The primary goals of the current study were to test my hypotheses that fluency misattribution plays a role in children’s judgments of how widely known information is among their peers, and that fluency misattribution in judging others’ knowledge declines with age. I tested these hypotheses by examining whether manipulating the frequency with which the information was presented to children (and thereby making that information more fluent) would influence their judgments of how common that knowledge is among their peers. I was also interested in whether the effect of fluency relates to children’s source monitoring abilities and performance on a curse of knowledge task. My findings revealed, as predicted, that children’s judgments of how widely known certain information is among their peers is affected by the frequency with which they have recently heard that information themselves. Specifically, children who heard items repeated frequently (e.g., a group of hippos six times) estimated that the knowledge would be more well known compared to those items heard only once (e.g., a group of giraffes). That is, overall, children chose the highly frequent groups of animals more often than chance, overestimating how common that knowledge would be among others.

However, contrary to my hypothesis that older children would be less susceptible to fluency misattribution than younger children, the tendency to judge that more children would know about the highly fluent groups of animals did not change with age. That is to say, the youngest participants (i.e., 4-year-olds) were no more likely to misattribute fluency than the oldest participants (i.e., 6- to 7-year-olds). I had expected that fluency misattribution would decline with age given the age-related changes in the curse of knowledge bias (showing improvements with age). I hypothesized that a decreased susceptibility to fluency misattribution with age could account for the age-related decline in the curse of knowledge bias. In contrast, my
results suggest that any age related changes that exist in the curse of knowledge bias are unlikely to be accounted for by the developmental changes in fluency misattribution (the section on Limitations and Future Research will address this further).

As expected, however, children’s performance on the fluency task was correlated with their performance on the source monitoring task. What this suggests is that fluency misattribution decreases as source monitoring capabilities increase. With age children’s source monitoring abilities improve and their increased ability to engage in source monitoring appears to make them less susceptible to misattributing the source of their fluency when judging what others know. As previously mentioned, fluency misattribution appears to be a type of source misattribution or source monitoring error; that is, when you do not remember the source of the fluency (i.e., how it came to be processed so fluently) you are more susceptible to misattribution errors. Given that young children exhibit poor source monitoring abilities, it increases their susceptibility to fluency misattribution errors. It may be worth noting, however, that although the fluency misattribution process is believed to only occur when the person forgets the source of their fluency (or at least is much greater when they forget) it may be possible to recall the source of one’s fluency and still misinterpret the fluency as an indicator of how common that knowledge is among others. For example, I know explicitly that information about the curse of knowledge is fluent to me because I think and talk about it on a regular basis, but I may still be influenced by the ease with which the information comes to my mind when inferring what others know. Perhaps because in those moments when you are inferring what others know you are not actively thinking about the source of your fluency. It is important to note, however, that the relationship between children’s performance on the source monitoring task and the fluency task held even when controlling for the age related changes observed in source monitoring. This
suggests that individual differences (not just age related differences) in one’s general source monitoring abilities make children more or less susceptible to fluency misattribution when judging what others know.

Contrary to my hypothesis that the curse of knowledge would decline with age, the results revealed that children’s performance on the curse of knowledge task was not correlated with performance on the fluency task. One possibility for the lack of relationship here is because of the unexpected performance on the curse of knowledge task itself. That is, recall that contrary to my hypothesis, and previous literature, 6- and 7-year-olds were the only age group to display a significant curse of knowledge bias. This may be due to the limitations in the design noted above (e.g., the order of the tasks). However, an important factor to consider is that the current study was the first test of the third manifestation of the curse of knowledge in children; that is, judgments of how common knowledge is. These data raise the possibility that the curse of knowledge in children’s judgments of how prevalent knowledge is follow a different developmental trajectory then has been observed in the other two manifestations of this bias.

Another possible reason for the lack of relationship between children’s performance on the curse of knowledge task and their performance on the fluency task is that an additional mechanism is involved in the curse of knowledge task that is not being called upon in the fluency task. In the current fluency task I only manipulated the frequency with which children heard certain items (e.g., a group of hippos) within a set of stories. I did not teach them the actual answers to any of the items (e.g., a group of hippos is called a pod). Doing so allowed me to examine the unique role of the fluency associated with an item without any content knowledge to inhibit. That is, it was designed to be a strict test of the unique role of fluency.
Conversely, in the curse of knowledge task (and in many real world situations) the effects of fluency misattribution are likely to be even greater by having the presence of knowledge content, and the frequency of the information, compounded. For example, consider the anecdote from the beginning of my paper: the morning recess bell rings and the children gather around the playground to begin a game of ‘grounders’ that they play everyday. A boy new to the school sees the game ensue while observing cautiously from the sidelines. The other children encourage the boy to join in and are shocked to learn that he does not know how to play. The reason for the children’s shock at the boy’s ignorance is not only because they play it everyday (fluency misattribution) but also because they know the rules of the game and how to play (knowledge content) and have to inhibit that knowledge. I suspect that the lack of relationship between children’s performance on the curse of knowledge and fluency misattribution is largely because the curse of knowledge task is primarily tapping children’s inhibitory control. What I propose here is similar to the effects we found in the Birch et al. (under review) paper that I discussed previously on page 24. The results of this study revealed that both knowledge content on its own (e.g., knowing that Farnsworth and Jenkins invented the TV but hearing it only once) and the frequency with which the information was presented on its own (e.g., repeatedly reading the question “Who invented the TV?” without the answer) significantly contributed to the curse of knowledge bias. Importantly, however, there was a larger effect for knowledge content in isolation than for frequency on its own, suggesting overestimations in how common knowledge is among others are greater when there is specific content knowledge to inhibit.

I want to acknowledge that when people are reasoning about the knowledge of others there may be several contributing factors (or mechanisms) that come in to play besides inhibitory control and fluency misattribution. For example, individuals may use a self-projection or ‘like
me’ type of attribution, whereby they assume that others will have similar knowledge to their own. That is to say, when considering what others know, it is reasonable to assume that others will have similar minds to me if they are ‘like me’; if you are ‘like me’ you may know what I know (and not know what I do not know). For example, a child may easily consider other children of the same age, race, or gender to be ‘like them’ and use their own knowledge to judge the knowledge of their peers; however, children of a different age, race, or gender may not be considered ‘like me’. Indeed, when making inferences about what others know people often do take into consideration the specific characteristics of the individual whose knowledge they are attempting to infer such as age, intelligence, hobbies, or profession just to name a few (e.g., Danovich & Keli, 2004). However, on its own the ‘like me’ framework does not seem to be a good account of the existing data on the curse of knowledge bias specifically. For instance, meta-analyses of the bias in adults revealed no differences between the three different manifestations of the curse of knowledge bias (Christensen-Szalanski & Willham, 1991). That is, people’s performance on the hindsight bias memory task (whereby one’s current knowledge biases their memory of their earlier perspective) is not different from their performance when judging the knowledge of a particular person or group of people. If participants were relying on a ‘like me’ framework they should be more accurate when recalling their own earlier perspective than inferring someone else’s; after all my earlier self (only weeks ago) ought to be the ultimate candidate for being ‘like me’.

Furthermore, with regard to the curse of knowledge in children, recall the aforementioned Birch and Bloom (2003) experiment where they investigated 3- to 5-year-olds’ ability to infer another individual’s knowledge regarding the contents of different containers when the children were either informed or uninformed as to the contents of the containers. In this study, children
saw two sets of containers, one set which was familiar to the experimenter’s puppet friend Percy and the other set which was unfamiliar to Percy. On half of the trials children saw what was inside both sets of containers, whereas during the other half of the trials children did not see inside either set of containers. The results of this study demonstrated that when children knew the contents of the containers they overestimated what Percy would know; that is, they were cursed by their knowledge. Conversely, when children did not know the contents of the containers they were more accurate in their judgments of what Percy would know. That is, there was not a ‘curse of ignorance’, which suggests an asymmetric perspective-taking error that is not simply the result of egocentrism or self-projection of one’s perspective onto another. If children were relying solely on a ‘like me’ framework it is unclear why it would only apply when they are knowledgeable and not when they are ignorant. Additional research by Taylor, Cartwright, and Bowden (1991) suggests that young children are unlikely to use the ‘like me’ framework at all.

In this study Taylor and colleagues (1991) found that knowledge judgments were not affected by the age of the observer, whether it was a 6-month-old baby, a 4-year-old child (like them), or an adult. More specifically, 4-year-old children tended to give the same answers to questions about a person’s knowledge of the identity of a partially-occluded image (that the children themselves knew), regardless of the observer’s age, implying that how ‘like them’ the target is did not matter for these types of judgments. Their results demonstrated that it is not until 6 years of age that children differentiate between what a 6-month-old baby might know versus what a similar aged peer might know versus what an adult might know.

Of course, I am not suggesting that a ‘like me’ framework does not ever play a role in people’s judgments of what others are likely to know. For instance, there is a large body of work in the adult literature that refers to ‘anchoring and adjustment’ (e.g., Pohl & Hell, 1996; Tversky
The logic here is that our own point of view is the best starting point or ‘anchor’ for inferring others knowledge and then we ‘adjust’ according to other information we have available. It seems probable that our assessment of how ‘like me’ the target is will affect the adjustment process (e.g., more adjustment for someone in Sub-Saharan Africa, and less for a family member or same aged peer). A full discussion of anchoring and adjustment is beyond the scope of this paper, but it might be interesting to note that a whole host of factors have been shown to influence one’s degree of adjustment, including whether you are nodding or shaking your head while making judgments of what others know (see e.g., Pohl & Hell, 1996 for a review). I suspect that one’s ability to inhibit information is also an important part of the adjustment process. Notably, when people are ignorant about a particular fact and required to infer what others know about that fact there is not any information to inhibit, thereby simplifying the adjustment process (i.e., no ‘curse’ of ignorance).

One should not forget as well that the curse of knowledge bias appears to be a by-product of an adaptive learning system (as discussed previously) (Hoffrage, Hertwig, & Gigerenzer, 2000; Henriksen & Kaplan, 2003). The curse of knowledge bias is the result of continuous updating that occurs to our knowledge structures when an individual acquires new information. Updating tends to occur so efficiently that it becomes challenging to disengage from the new information, even when one’s goal is to reason about a naïve perspective. That is to say, after learning new information one’s ability to imagine a perspective that lacked (or currently lacks) this information becomes limited. It serves an adaptive function by keeping track of new events and focusing our cognitive resources towards new knowledge, which is critical for functioning in our ever-changing environment (Hoffrage, Hertwig & Gigerenzer, 2000).
Limitations and Future Research

It is important to acknowledge that there are limitations with the current design. One area of improvement could be made with the force-choice format of the test question (e.g., “Will more kids know what a group of hippos is called or what a group of giraffes is called?”). This current test question is rather wordy and may unnecessarily increase the cognitive and verbal demands for young children. Another way to tap the test question in future versions of the fluency task would be to ask about each of the groups of animals in turn. For example, “How many kids will know what a group of hippos is called? A lot? Or a few?” Subsequently, (in a second test question) children could be asked “How many kids will know what a group of giraffes is called? A lot? Or a few?” Dividing up the test question into two separate questions could decrease the cognitive load (e.g., the need to hold two concepts in mind) and verboseness of the test question. Another question for future research is whether children are aware of the fluency manipulation within the stories of the fluency task. For instance, one could ask, “Did I tell you more about hippos or giraffes?” Doing so would garner more insight into children’s awareness (or lack of awareness) of fluency and its effects on judgments of how common knowledge is among others. It should also be acknowledged that I may have introduced two different types of fluency in the stories of the fluency task: 1) the repetition of the phrase “group of X”; and 2) conceptual fluency brought on by the additional information in the sentences (e.g., a group of hippos playing in the water of a nearby swamp; or the group of hippos was enjoying a game of hide-and-seek). Future work could attempt to tease these two types of fluency apart and test the relative contributions of the different kinds of fluency more generally.

Improvements could also be made to aid in interpreting the results of the curse of knowledge task. Due to the surprising result that 6- to 7-year-olds were the only age group to
display a significant difference in the curse of knowledge bias on their own, future designs should counterbalance the order in which children participate in the tasks. Doing so will help to determine if counterbalancing the placement of the tasks allows me to capture the developmental changes previously observed in the curse of knowledge or whether there are indeed different developmental trajectories for the different manifestations of the bias. Future work would also benefit from more carefully controlling the frequency with which the taught items and not taught items are mentioned in the curse of knowledge task. Currently, the curse of knowledge task inadvertently introduced a fluency manipulation because participants heard about the taught item twice, while they only heard about the untaught item once. For example, children heard “a group of leopards” once for the untaught item and then they heard the taught item twice, “a group of zebras. A group of zebras is called a dazzle.” Future designs could utilize the following structure for instance:

“This is a story about Ben and his visit to Africa. Ben visited all the animals that lived in Africa. The first animals Ben saw were a group of leopards. The second animals Ben saw were a group of zebras, which are called a dazzle. Can you say that? A dazzle? That’s right! Ben had a great time visiting all the animals that lived in Africa.”

On a similar note, my curse of knowledge design is the first to use a force-choice design for the test question (e.g., “Will more kids know what a group of leopards is called or what a group of zebras is called?”). Perhaps the force-choice nature of the test question is not able to effectively capture the developmental differences in the curse of knowledge. Future designs could utilize a more continuous measure and an accompanying picture scale that has been clearly demonstrated to young children. For example, “How many children will know X? None, a couple, a few, a lot,
or a whole lot?” This design is currently being used with success in other work in my lab (Ghrear, Unpublished master’s thesis).

There is also room for improvement in the source monitoring task. As previously noted, the source monitoring results should be interpreted with some caution. It is difficult to determine with certainty whether children’s source monitoring abilities are improving with age, or conversely they say ‘yes’ less with age (especially for questions they are uncertain about) because of age related changes in the ‘yes’ bias (Okanda and Itakura, 2010), though the current results are consistent with a body of other work on children’s source monitoring abilities (Gopnik & Graf, 1988, Robinson, 2000). A suggestion for future research would be to force choice the source monitoring task questions to avoid yes/no responses. For example, “When did you learn that a pig says ‘oink oink’? Did you learn it today or before today?”

Implications

The current research sheds light on the mechanisms that underlie the curse of knowledge bias, and advances our understanding of how people reason about or infer what others know. My research is the first to show that the frequency with which children hear information contributes to their judgments of how widely known that information is among others. In many cases, using frequency to judge the likelihood that others have been exposed to that same information is a very useful heuristic. However, as in adults, this heuristic can seemingly lead children awry and they can misattribute the fluency (resulting from hearing something frequently) to how widely known that information is to others.

Although I found a somewhat small effect of fluency, the effects are likely even greater in the real world. As previously mentioned, usually when you know something (e.g., the meaning of the word ‘arduous’) you have the compounding effects of content knowledge to
inhibit (i.e., its meaning) and the frequency with which you have encountered the information to
discount. Due to this compounding effect there is probably a greater likelihood that children
would misattribute the source of their fluency outside of the laboratory within more applied
settings. Research in this area helps to inform researchers about possible de-biasing techniques to
reduce the curse of knowledge bias. Thus far, de-biasing techniques have largely been
unsuccessful, impractical, or too task-specific (for examples of de-biasing techniques see Pohl &
Hell, 1996; Camerer et al., 1989; Sutherland et al., 2015; Sanna, Schwarz, & Small, 2002; Muller
& Stahlberg, 2007). Consider one practical lesson I learned from this research: the more times I
have read this document the more fluent it has become for me to process (e.g., the sentences
seem to flow more easily with each successive reading given that I know what words and
arguments come next). Consequently, the more likely I am to feel that the information will also
be clear to others. A partial de-biasing technique was for me to set aside the paper for a period of
time before my final re-read (i.e., a time lag disrupts fluent sentence processing) allowing me to
gain a perspective more akin to a naïve reader. That is, when I return to writing at a later point in
time with ‘fresh eyes’ it is easier to detect what parts are unclear and more accurately determine
what I need to write in order to be effectively understood by my readers. I hope it helped!

Future research testing the efficacy of specific de-biasing techniques will help to foster
more accurate perspective-taking abilities, which has important implications for both basic and
applied research initiatives. For example, establishing effective de-biasing techniques will
provide the groundwork for intervention techniques aimed at fostering social perspective-taking
skills, that should in turn result in corresponding improvements in other facets of social
competence related to perspective-taking (e.g., prosocial behaviour, peer relationships, better
communication, and decision making). It is exceedingly important for children to learn to
differentiate between privileged information (i.e., information only they know) and common knowledge (i.e., information known more generally). To do this, we as researchers need to test ways to facilitate more metacognitive awareness (i.e., introspective knowledge about one’s own knowledge) and promote better source monitoring abilities in children. Doing so should enable children to be less likely to misattribute the source of the information and enhance their overall perspective-taking abilities. Developmental research in this area is especially important because early interventions are likely to have the greatest impact on both cognitive and social growth.
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Appendix A: Materials
Appendix B: Experimenter Script

**VERSION 3A**

“Hi, I’m ___. What’s your name? Nice to meet you _______.”

[Warm child up by asking his/her age, whether he/she has pets, and what kinds of things he/she likes to do.]

**TRAINING:**
“I have a fun game to play. Would you like to play with me?”
“Great! I’m going to ask you some questions but remember there are no right or wrong answers, I just want to know what you think, ok?”

“Let’s try a question! Which picture has more kids?” [Have visuals of stick figures (i.e., 2 vs 7) in front of the child. Let the child determine which picture has more kids].

**Prompts:** If the child has difficulty, depending on the nature of their difficulty do the following (note which prompts are needed):
1. Repeat the question: “Which picture has more kids?”
2. If no answer, count the number of stick figures on each picture with the child and say: “Which picture had more kids, the picture with 2 kids (point to the visual) or the picture with 7 kids (point to the visual)?”

**ANSWER** (circle the child’s response): 7 or 2

“Okay, I have another question for you. Do more kids like to eat fruit or bugs?” [Have only the visual with 7 stick figures present alongside the picture of bugs and the picture of fruit].

**Prompts:** If the child has difficulty, depending on the nature of their difficulty do the following (note which prompts are needed):
1. Repeat the question: “Do more kids like to eat fruit or bugs?”
2. If no answer say: “Will more kids like to eat fruit (point to the visual) or bugs (point to the visual)?”

**ANSWER** (circle the child’s response): FRUIT or BUGS

“Great job! Let’s do one more. Do more kids know a group of birds is called a flock or a group of camels is called a caravan?” [Have only the visual with 7 stick figures present alongside the picture of the group of geese and the picture of the group of camels].

**Prompts:** If the child has difficulty, depending on the nature of their difficulty do the following (note which prompts are needed):
1. Repeat the question: “Do more kids know a group of birds is called a flock or a group of camels is called a caravan?”
2. If no answer say: “Will more kids know a group of birds is called a flock (point to the visual) or a group of camels is called a caravan (point to the visual)?”

**ANSWER** (circle the child’s response): BIRDS or CAMELS
**FLUENCY STORIES:**
[For each of the Fluency stories ensure that you have both stick figure visuals (i.e., 2 vs. 7) along with the visuals of the animals that correspond to the appropriate story placed out in front of the child].

“Ok, now I am going to read you some stories and ask you a few questions and I want you to guess how many other children will know the right answer to the questions.”

“This is a story about Bruce and his visit to a safari exhibit. Bruce walked around visiting all the animals at the safari exhibit. The first animals Bruce saw were a group of hippos. It was early in the afternoon when Bruce saw [the group of hippos] playing in the water of a nearby swamp. [The group of hippos] was enjoying a game of hide-and-seek. It took a long time for [the group of hippos] to find one another hidden amongst all the murky water and plants of the swamp. As evening drew near [the group of hippos] grew hungry and left the swamp in search of some food. They eventually found a nice field of grass to eat for dinner. After dinner was through [the group of hippos] spent the evening talking and relaxing under the stars about their afternoon of fun. The second animals Bruce saw were a group of giraffes. Bruce had a great day visiting the animals at the safari exhibit.”

“That’s the end of the story. Now, I have a question for you”: 

“Will more kids know what a group of giraffes is called or what a group of hippos is called?”

**ANSWER** (circle the child’s response): GIRAFFES or HIPPOS

“You’re doing great! Here’s another story.”

“This is a story about Jessie and her visit to a jungle exhibit. Jessie walked around visiting all the animals at the jungle exhibit. The first animals Jessie saw were a group of monkeys. Today [the group of monkeys] were excited because the babies were finally big enough to learn to climb and play on their own. [The group of monkeys] had patiently been waiting to teach the babies how to climb up the trees. [The group of monkeys] first taught the babies how to climb up to the top of a big tree. Then [the group of monkeys] showed the babies how to swing from tree to tree. After an afternoon spent swinging and climbing trees they all grew hungry. [The group of monkeys] took the babies to the top of a large fruit tree where they ate until their tummies were full. The second animals Jessie saw were a group of sloths. Jessie had a great day visiting all the animals at the jungle exhibit.”

“That’s the end of the story. Now, I have a question for you”: 

“Will more kids know what a group of sloths is called or what a group of monkeys is called?”

**ANSWER** (circle the child’s response): SLOTHS or MONKEYS
“Nice work! Let’s do another one.”

“This is a story about Joey and his early morning walk around the forest near his country home. Joey walked around looking for animals that lived near his house. The first animals Joey saw were a group of bears. It was early in the morning when Joey saw [the group of bears] eating berries off a bunch of blackberry bushes. After some time eating [the group of bears] grew curious and began to move towards the sounds of a nearby river. The river was filled with the loud splashing sounds of salmon trying to make their way up the river. [The group of bears] jumped into the water and tried to catch as many salmon to eat as possible. Once [the group of bears] grew full they decided to bathe in the fresh water to clean their paws and fur. Afterwards [the group of bears] decided to lie on a nice soft patch of grass to dry under the hot midmorning sun. The second animals Joey saw were a group of badgers. Joey had a great morning looking for animals that lived around the forest near his country home.”

“That’s the end of the story. Now, I have a question for you”:

“Will more kids know what a group of badgers is called or what a group of bears is called?”

ANSWER (circle the child’s response): BADGERS or BEARS

“Awesome! Let’s read one more story.”

“This is a story about Anne and her visit to an Arctic exhibit. Anne walked around visiting all the animals at the Arctic exhibit. The first animals Anne saw were a group of walruses. [The group of walruses] was swimming together trying to find a nice patch of ice to lie around. It was a warm sunny day and [the group of walruses] was trying to warm their bodies in the midday sun. After [the group of walruses] found the biggest and best piece of ice they all stretched out and fell asleep against the ice for an afternoon nap. [The group of walruses] slept for most of the afternoon and into the evening. When [the group of walruses] finally awoke it was dark and all the stars were shining bright. They spent the evening seeing who could count the most stars in the midnight sky. The second animals Anne saw were a group of killer whales. Anne had a great day visiting all the animals at the Arctic exhibit.”

“That’s the end of the story. Now, I have a question for you”:

“Will more kids know what a group of killer whales is called or what a group of walruses is called?”

ANSWER (circle the child’s response): KILLER WHALES or WALRUSES

“Great job! I have a few more questions for you.”

“Will more kids know what a group of elephants is called or what a group of rhinos is called?”
“Will more kids know what a group of rabbits is called or what a group of raccoons is called?”

**ANSWER** (circle the child’s response): RABBITS or RACCOONS

“Will more kids know what a group of sea turtles is called or what a group of jellyfish is called?”

**ANSWER** (circle the child’s response): SEA TURTLES or JELLYFISH

“Will more kids know what a group of pigs is called or what a group of goats is called?”

**ANSWER** (circle the child’s response): PIGS or GOATS

Curse of Knowledge Task:

Note: there are no animal visuals needed for this portion of the task, but have both stick figure visuals (i.e., 2 vs. 7) placed out in front of the child.

“Ok, now I am going to read you some stories and ask you a few questions and I want you to guess how many other children will know the right answer to the questions.”

“This is a story about Ben and his visit to Africa. Ben visited all the animals that lived in Africa. The first animals Ben saw were a group of zebras. The second animals Ben saw were a group of leopards. A group of leopards is called a leap. Can you say that? A leap? ___That’s right! Ben had a great time visiting all the animals that lived in Africa.”

“That’s the end of the story. Now, I have a question for you”:  

“Will more kids know what a group of leopards is called or what a group of zebras is called?”

**ANSWER** (circle the child’s response): LEOPARDS or ZEBRAS

“You’re doing great! Here’s another story.”

“This is a story about Jane and her visit to British Columbia. Jane visited all the animals that lived in British Columbia. The first animals Jane saw were a group of squirrels. The second animals Jane saw were a group of porcupines. A group of porcupines is called a prickle. Can
you say that? A prickle? __That’s right! Jane had a great time visiting all the animals that lived in British Columbia.”

“That’s the end of the story. Now, I have a question for you”: 

“Will more kids know what a group of porcupines is called or what a group of squirrels is called?”

**ANSWER** (circle the child’s response): PORCUPINES or SQUIRRELS

“Nice work! Let’s do another one.”

“This is a story about Sunny and his visit to Australia. Sunny visited all the animals that lived in Australia. The first animals Sunny saw were a group of emus. The second animals Sunny saw were a group of kangaroos. A group of kangaroos is called a troop. Can you say that? A troop! __That’s right! Sunny had a great time visiting all the animals that lived in Australia.

“That’s the end of the story. Now, I have a question for you”: 

“Will more kids know what a group of kangaroos is called or what a group of emus is called?”

**ANSWER** (circle the child’s response): KANGAROOS or EMUS

“Awesome! Let’s read one more story.”

“This is a story about Kaela and her visit to Florida. Kaela visited all the animals that lived in Florida. The first animals Kaela saw were a group of crocodiles. The second animals Kaela saw were a group of deer. A group of deer is called a gang. Can you say that? A gang? __That’s right! Kaela had a great time visiting all the animals that lived in Florida.”

“That’s the end of the story. Now, I have a question for you”: 

“Will more kids know what a group of deer is called or what a group of crocodiles is called?”

**ANSWER** (circle the child’s response): DEER or CROCODILES

“Awesome job! I have a few more questions for you!

“Did you know that a pig says ‘oink oink’ before today?” Y or N

“Did you know that a group of leopards is called a leap before today?” Y or N
“Did you know that the stars come out at night before today?” Y or N

“Did you know that a group of porcupines is called a prickle before today?” Y or N

“Did you know that the colour green means 'go' before today?” Y or N

“Did you know that a group of kangaroos is called a troop before today?” Y or N

“Did you know that fish live in the water before today?” Y or N

“Did you know that a group of deer is called a gang before today?” Y or N

“Did you know what a group of hippos is called before today?” Y or N

“Did you know what a group of giraffes is called before today?” Y or N

“Did you know what a group of monkeys is called before today?” Y or N

“Did you know what a group of sloths is called before today?” Y or N

“Did you know what a group of bears is called before today?” Y or N

“Did you know what a group of badgers is called before today?” Y or N

“Did you know what a group of walruses is called before today?” Y or N

“Did you know what a group of killer whales is called before today?” Y or N

“Thanks so much for helping me with the games, you did a wonderful job.”
Appendix C: Example of Test Set Up
Appendix D

Table 1. Breakdown of Differences by Item/Question

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</thead>
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<tr>
<td><strong>Fluency Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Will more kids know what a group of hippos is called or what a group of giraffes is called?</td>
<td>0.57</td>
<td>0.50</td>
<td>.163</td>
<td>0.26</td>
</tr>
<tr>
<td>2 Will more kids know what a group of monkeys is called or what a group of sloths is called?</td>
<td>0.58</td>
<td>0.50</td>
<td>.076</td>
<td>0.34</td>
</tr>
<tr>
<td>3 Will more kids know what a group of bears is called or what a group of badgers is called?</td>
<td>0.58</td>
<td>0.50</td>
<td>.076</td>
<td>0.34</td>
</tr>
<tr>
<td>4 Will more kids know what a group of walruses is called or what a group of killer whales is called?</td>
<td>0.47</td>
<td>0.50</td>
<td>.516</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Curse of Knowledge Task</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 Will more kids know what a group of zebras is called or what a group of leopards is called?</td>
<td>0.56</td>
<td>0.50</td>
<td>.227</td>
<td>0.23</td>
</tr>
<tr>
<td>2 Will more kids know what a group of squirrels is called or what a group of porcupines is called?</td>
<td>0.59</td>
<td>0.50</td>
<td>.050</td>
<td>0.37</td>
</tr>
<tr>
<td>3 Will more kids know what a group of emus is called or what a group of kangaroos is called?</td>
<td>0.59</td>
<td>0.50</td>
<td>.050</td>
<td>0.37</td>
</tr>
<tr>
<td>4 Will more kids know what a group of crocodiles is called or what a group of deer is called?</td>
<td>0.58</td>
<td>0.50</td>
<td>.076</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Source Monitoring Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Old Items</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Did you know that a pig says ‘oink oink’ before today?</td>
<td>0.83</td>
<td>0.37</td>
<td>&lt; .001</td>
<td>1.80</td>
</tr>
<tr>
<td>2 Did you know that the stars come out at night before today?</td>
<td>0.94</td>
<td>0.24</td>
<td>&lt; .001</td>
<td>3.67</td>
</tr>
<tr>
<td>3 Did you know that the colour green means go before today?</td>
<td>0.89</td>
<td>0.32</td>
<td>&lt; .001</td>
<td>2.44</td>
</tr>
<tr>
<td>4 Did you know that fish live in the water before today?</td>
<td>0.95</td>
<td>0.22</td>
<td>&lt; .001</td>
<td>4.03</td>
</tr>
<tr>
<td><strong>New Items (Taught Set #1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Did you know that a group of leopards is called a leap before today?</td>
<td>0.63</td>
<td>0.49</td>
<td>.050</td>
<td>0.53</td>
</tr>
<tr>
<td>2 Did you know that a group of porcupines is called a prickle before today?</td>
<td>0.59</td>
<td>0.50</td>
<td>.154</td>
<td>0.38</td>
</tr>
<tr>
<td>3 Did you know that a group of kangaroos is called a troop before today?</td>
<td>0.61</td>
<td>0.49</td>
<td>.091</td>
<td>0.45</td>
</tr>
<tr>
<td>4 Did you know that a group of deer is called a gang before today?</td>
<td>0.61</td>
<td>0.49</td>
<td>.091</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>New Items (Taught Set #2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Did you know that a group of zebras is called a dazzle before today?</td>
<td>0.52</td>
<td>0.50</td>
<td>.792</td>
<td>0.07</td>
</tr>
<tr>
<td>2 Did you know that a group of squirrels is called a scurry before today?</td>
<td>0.57</td>
<td>0.50</td>
<td>.289</td>
<td>0.29</td>
</tr>
<tr>
<td>3 Did you know that a group of emus is called a mob before today?</td>
<td>0.46</td>
<td>0.50</td>
<td>.597</td>
<td>0.14</td>
</tr>
<tr>
<td>4 Did you know that a group of crocodiles is called a float before today?</td>
<td>0.48</td>
<td>0.50</td>
<td>.792</td>
<td>0.07</td>
</tr>
</tbody>
</table>

*Note: p-values are not Bonferroni-adjusted for multiple tests