VARIATIONS IN CHILDREN'S USE OF INDIVIDUALS' PAST ACCURACY

by

PATRICIA ÉLISABETH BROSSEAU-LIARD

B.Sc. Hons., McGill University, 2006

M.A., University of British Columbia, 2008

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Abstract

Young children learn an abundance of information about the world from other people. Yet, people sometimes provide inaccurate or questionable information. Hence, when learning from others, it is advantageous to be selective and evaluate the likely accuracy of the information and its source. Previous research has shown that preschool-age children can attend to a variety of cues indicative of others' knowledge and use those cues to guide their learning. Yet, just because children can use knowledge cues to guide their selective learning does not mean that they do so, or even should do so, in all circumstances. The present research assessed children's understanding of whether these cues predict a person's future knowledge of different types of information by examining variations in children's use of an individual's past accuracy depending on the type of information being learned. Experiments 1 to 3 demonstrated that 4-year-olds generalized past accuracy in a savvy way, using it to moderate their learning across different types of objective information but abstaining from generalizing to situations involving subjective information. In contrast, 3-year-olds (Experiments 1-2) used past accuracy narrowly, failing to generalize an individual's past accuracy in one area of knowledge to situations that involved learning in another area of knowledge. Experiments 4 and 5 investigated whether children ages 4 to 7 understand that past accuracy demonstrated with generalizable, or category-level, information is a useful predictor of other generalizable knowledge but not of idiosyncratic, or instance-specific, knowledge. Children used an individual's past accuracy to decide whether or not to learn generalizable information from that individual or from a different source, but wisely disregarded past accuracy when learning idiosyncratic information. Experiments 6 and 7 further demonstrated that 4- and 5-year-olds are more likely to use past accuracy when learning generalizable than idiosyncratic information and appropriately use others' information access to predict their idiosyncratic knowledge. Overall, this research demonstrates that preschool- and early-school-age children possess a nuanced understanding of the predictive value of knowledge cues for different types of knowledge. The implications of these results for children's developing understanding of the mind and other aspects of social cognition are discussed.

Preface

Modified versions of Chapters 2 and 3 are currently under review in academic journals (Chapter 2: Brosseau-Liard, P. E., Qiao, G., Vauthier, S., & Birch, S. A. J.. *Generalization of informants' past accuracy: Narrow, broad, or principled?* Manuscript under review. Chapter 3: Brosseau-Liard, P. E. *Selective social learning: Variations in children's use of individuals' prior accuracy.* Manuscript under review.) A modified version of Chapter 4 was published in the journal *Child Development*. I am first author on this manuscript, with my supervisor, Dr. Susan Birch, as co-author. Reference: Brosseau-Liard, P. E., & Birch, S. A. J. (2011). Epistemic states and traits: Preschoolers appreciate the differential informativeness of situation-specific and person-specific cues to knowledge. *Child Development*, *82*, 1788–1796. doi:10.1111/j.1467-8624.2011.01662.x.

Note that ¼ of the data in Experiment 7 (the *Label history – Point test* condition) was also part of my M.A. thesis. The analyses reported here however differ from those reported in the M.A. thesis as it includes only one age group (5-year-olds; the M.A. thesis also included 4-year-olds) and focus on comparing this condition to 3 other conditions rather than analysing it on its own. The theoretical focus of this paper is also substantially different. Reference: Brosseau-Liard, P. E. (2008). Preschool children's interpretation of others' history of accuracy. *Unpublished Master's thesis, University of British Columbia.*

For all experiments reported in this dissertation, I had the primary role in the design of the experiments and data analyses, with assistance and feedback from Dr. Susan Birch. I collected a large portion of the data myself, and three former research assistants (Grace Qiao, James Tan and Sophie Vauthier) collected the rest of the data. I drafted all manuscripts and subsequently incorporated feedback from Dr. Susan Birch, other co-authors for Chapter 2, my dissertation committee (Geoff Hall and Mark Schaller) and Janet Werker.

Ethics approval for all seven experiments included in the present dissertation was obtained from the Behavioural Research Ethics Board of the University of British Columbia (H04-80616 for data collected before August 2010; H10-01272 for data collected in and after August 2010).

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Chapter 1: Introduction

Overview and rationale

During the first few years of their lives, children need to acquire information about the world around them at a very rapid pace. Fortunately, children are helped in their learning by the information that others provide to them (e.g., Csibra & Gergely, 2009; Harris, 2007). However, informants are not always accurate: People lie, make mistakes, and frequently make statements that they are unsure about. Children's social learning thus has the potential to mislead them, unless they are savvy enough to use cues helping them determine whether information provided by an individual is likely to be accurate or not.

Research has demonstrated that preschool-age children can attend to a variety of cues that indicate the knowledge of an individual. For instance, in the past decade, numerous studies have demonstrated that preschoolers can attend to an individual's accuracy or inaccuracy and subsequently prefer to learn from someone who has been accurate rather than someone who has been inaccurate in the past (e.g., Birch, Vauthier & Bloom, 2008; Jaswal & Neely, 2006; Koenig, Clément & Harris, 2004; Koenig & Harris, 2005a; Scofield & Behrend, 2008). Children are also able to use a variety of other knowledge cues, such as an individual's access to information (e.g., O'Neill, 1996; Pillow, 1989; Pratt & Bryant, 1990; Robinson & Whitcombe, 2003) or confidence (e.g., Birch, Akmal & Frampton, 2010; Sabbagh & Baldwin, 2001; Tenney, Small, Kondrad, Jaswal & Spellman, 2011).

In order to fully understand children's social learning, however, it is not sufficient to know whether children *can* use various knowledge cues: It is also important to understand the situations under which children are more or less likely to actually use these cues. Very little research has been conducted on this topic. Given that the research showing that children can attend to many knowledge cues has been conducted only recently, it is understandable that little research has yet investigated variations in the use of these cues. This question, however, is the next logical step in this area of research.

The research presented in this dissertation aims to begin filling this gap in the literature by investigating circumstances under which children use individuals' past accuracy to moderate their social learning. Three sets of experiments focus on variations in the use of past accuracy that are driven by the type of information that is being learned. The present chapter first reviews relevant literature and discusses what past research has shown regarding children's evaluation of others' knowledge, then introduces the research questions that motivated the present research and provides an overview of the different experiments that were conducted.

Literature review

Social Learning.

Humans are a social species, who live in groups because it aids survival. One important part of living in social groups is communication of information. People regularly communicate information about the physical world, about other people, events, facts, conjectures, and so on. In humans, a large part of communication happens through language, but there are also non-verbal means of communication.

For children, communication from conspecifics has an obvious advantage: It allows them to learn information that they need to thrive in whatever environment they happen to live in. True, children can learn without the benefit of communication from social sources of information, such as through trial and error, exploration or observation. However, these modes of learning can be suboptimal for children, especially at a very young age. Learning directly from the outside world through exploration or experimentation can be difficult or impractical for young children, who are as of yet small, weak and have limitations in terms of fine motor skills. Learning directly from the world can also be dangerous: Some mistakes (e.g., choosing to eat something toxic) are just too costly for trial and error to be a viable source of information. In addition, some types of information are either very difficult or downright impossible to acquire without social sources of information (Harris & Koenig, 2006). In some cases, this is because of practical impediments to the acquisition of information: For instance, children cannot discover information about distant planets, complex chemical reactions, historical facts, or microscopic substances because they do not have the opportunity to observe this information for themselves (e.g., for some of these types of information, observation requires specialized equipment that children do not have access to and are not competent to operate). In other cases, children are learning information that is inherently social: For instance, language or customs can only be transmitted by other humans (e.g., learning the arbitrary strings of sounds that form words that correspond to real world objects and events cannot be accomplished through direct observation and inference or through trial and error)[1].

Congruent with these ideas, there is evidence that very early in life children are sensitive to a variety of cues from individuals that typically signal pedagogical transmission of information (see Csibra & Gergely, 2006, for a review). One early manifestation of this sensitivity is social referencing – that is, looking towards others to know how to react to unfamiliar stimuli (e.g., Feinman & Lewis, 1983). Throughout infancy and childhood, social learning is extremely important for children; indeed, some theorists have proposed that children's propensity for social learning is responsible for humans' uniquely complex cultural traditions and achievements (e.g., Tomasello & Rakoczy, 2003).

[1] Note that books, televisions and other such sources can be considered as indirect social sources since their contents are created by humans.

[2] Note that confidence can also be considered a person-specific trait: Some people are consistently more likely to express confidence than others. However, most research studying children's attention to confidence has investigated it as a situational knowledge cue. Thus, here I review the literature on children's sensitivity to confidence as a situational cue. How children are influenced by person-specific differences in confidence remains a question for future research.

[3] Herein, the term 'domain' simply denotes a particular category of knowledge or type of information. Its use here

The advantages of social learning, however, are only present if children are learning *accurate* information from others. Some philosophers have suggested that, in order for language and communication to have evolved, people must be conveying accurate information most of the time (see Sperber, Clément, Heintz, Mascaro, Mercier, Origgi & Wilson, 2010 for a review). Adults usually communicate very simple information to children (at least relative to what they communicate to other adults), and they are unlikely to be motivated to mislead them in order to compete with them. As mentioned above, some theorists have proposed that humans have a specific adaptation to teach the young, and that human children are especially attuned to cues suggesting a 'teaching moment', including child-directed speech and ostensive demonstrations (Csibra & Gergely, 2009; Gergely & Csibra, 2004).

Thus, children may be especially attuned to information conveyed by other people and biased to accept it unquestioningly. Young children indeed appear to be trusting by default: They often are overly reliant on testimony, even when it conflicts directly with their own perceptions or expectations (Jaswal, 2010). Three-year-olds also appear to find it especially difficult to resist the tendency to trust an individual's pointing gestures when gathering information about where to search for a specific object, even after repeated trials demonstrate that the individual systematically points to the wrong location (Jaswal, Croft, Setia & Cole, 2010). In some circumstances, children also "overimitate" – that is, they imitate a sequence of actions extremely faithfully even if it is obvious that a certain step in the sequence of actions is physically unnecessary to produce the desired outcome (e.g., Lyons, Young & Keil, 2007). Young children also appear more likely than older individuals to incorporate inaccurate suggestions from others into their memory of a past event, something that has been investigated extensively in the context of eyewitness testimony (see Ceci & Bruck, 2006 for a review).

Research also suggests that children tend to encode information presented in a pedagogical manner as normative and generalizable information. For example, a recent study by Topal, Gergely, Miklósy, Erdőhegyi and Csibra (2008) investigated the "A-not-B error" first demonstrated by Piaget (1954), where infants tend to repeatedly search for an object in the first location where they found it even in subsequent events where they witnessed the object being hidden elsewhere. Topal et al. (2008) demonstrated that, in the absence of ostensive communicative cues from an experimenter, infants' propensity to show this error decreases dramatically: It is as if the ostensive cues led infants to interpret the object's initial location as the "normative" search place. Note that a tendency to trust testimony by default may not be specific to childhood. In fact, some studies suggest that adults have a "truth bias", and have difficulty using information suggesting that a certain fact is false when pressed for cognitive resources (e.g., Gilbert, Krull & Malone, 1990; although see Hasson, Simmons & Todorov, 2005 and Richter, Schroeder & Wöhrmann, 2009 for counterproposals).

Communication, however, is not always accurate: People lie, make mistakes, and sometimes convey information despite being poorly informed. In fact, parents do, in some contexts, provide unreliable information to their children (e.g., Henderson & Sabbagh, 2010). Moreover, a considerable amount of information people convey is a matter of subjective opinion (e.g., the best hockey team) rather than objective truths. Hence, though it might be advantageous for children to trust testimony, it would be even more advantageous if they were selective in their trust. Being attentive to cues that help determine whether information that is conveyed is accurate or not, and having the ability to refrain from learning or tag information as questionable when cues suggest that credibility is compromised, would give children all the advantages of social learning while considerably reducing its drawbacks.

One might think that such a skill would be out of the reach of young children, who are notoriously gullible. In addition to widespread belief in things such as the existence of monsters, Santa Claus and the tooth fairy, it is relatively easy to convince a young child of various improbable things, such as that an invisible princess is watching them (Bering & Parker, 2006; Piazza, Bering & Ingram, 2011) or that researchers possess a magical machine that can shrink or enlarge objects (DeLoache, Miller & Rosengren, 1997) or duplicate objects (Hood & Bloom, 2008). Children also sometimes believe that something they have merely imagined could spontaneously become real (Johnson & Harris, 1994) and that they can make something come true by simple wishing or employing a magical spell (e.g., Vikan & Clausen, 1993; Subbotsky, 1994). They also are quite willing to accept information about counterintuitive real-life phenomena, such as the earth being round and going around the sun, and claims that many adults around them believe but cannot prove, such as the existence of deities (Harris & Koenig, 2006). Furthermore, preschool children are not very good at remembering the source of their own knowledge, for example failing to differentiate something they know from direct observation, something they know from hearsay, and something they have merely guessed (Gopnik & Graf, 1988; see also O'Neill & Gopnik, 1991; Robinson & Whitcombe, 2003). Preschoolers sometimes claim that they have always known something they have just learned, suggesting that the source of their knowledge does not play an important role in their evaluation of the information they learn (Taylor, Esbensen & Bennett, 1994). This lack of source monitoring in early childhood might lead one to predict that tracking the reliability of knowledge sources should be difficult; indeed, there is evidence in young children that poor source monitoring is correlated with greater suggestibility (Giles, Gopnik & Heyman, 2002).

All these trends (i.e., children's tendency for default trust, their high suggestibility and their poor source monitoring abilities) might lead one to predict that children should be easily misled and often learn false information. However, children's reputation for being gullible is somewhat overstated. First, a certain degree of magical thinking is by no means unique to childhood (e.g., Gallup & Newport, 1990; Subbotsky, 2005; Vyse, 1997), yet adults are capable of critically evaluating information despite this propensity. Second, though they may appear naïve, even young children can distinguish reality from fantasy to a certain extent (e.g., Harris, Brown, Marriott, Whittall & Harmer, 1991; Woolley & Phelps, 1994; Woolley, 1997). For instance, preschoolers are especially likely to attempt to formulate explanations for events that violate their expectations (Legare, Gelman & Wellman, 2010). Children are also not universally trusting: For instance, they are more likely to be skeptical of someone's claims when presented with information that is surprising (Jaswal, 2004) or clashes with their own perceptions (Robinson, Champion & Mitchell, 1999). In fact, children are sometimes more likely to hold incorrect but more intuitive explanations of how the world works (for example, that humans were created by an omniscient being) rather than the more accurate but less intuitive explanations that their parents believe in (for example, that humans evolved from an ape-like ancestor; Evans, 2000).

Cues to evaluate social sources of knowledge.

It is thus possible for children to moderate their social learning depending on whether the information they are learning seems plausible or surprising. However, another way of moderating social learning is to evaluate the trustworthiness of the *source* of the information. There exists many possible cues one can use to evaluate an informant's potential credibility, some of which are listed below.

Non-epistemic cues. One possible cue, for a young child, is familiarity: A known adult towards whom a child feels positively, be it a parent, a teacher, or another acquaintance, is probably more likely to be trusted than an unfamiliar adult who, as far as the child knows, may or may not be knowledgeable and benevolent. Familiarity might be an especially potent cue for younger children who may have limited abilities to evaluate more complex or subtle cues. There is indeed evidence that preschoolers prefer to learn from a familiar individual over an unfamiliar one; in the youngest preschoolers, that preferential trust remains even if the familiar individual displayed inaccuracy immediately before children were given the opportunity to choose whom to trust (Corriveau & Harris, 2009a; see also Corriveau, Harris, Meins, Fernyhough, Elliott, Liddle et al., 2009).

Another relatively broad factor that may affect social learning is membership in one's social group, as indicated by any number of cues – language (including dialect and accent), skin color, culturally-determined habits, and so on. All else being equal, at least in our species' evolutionary history, a member of one's own social group is more likely to possess culturally-relevant knowledge and have benevolent dispositions towards oneself than a member of a different group. This ingroup preference appears especially likely to be triggered by language. Studies have indeed shown that infants and young children prefer individuals who speak the same language and with the same accent as themselves or their caregivers (Kinzler, Dupoux & Spelke, 2007; Kinzler, Shutts, Dejesus & Spelke, 2009), are more likely to help same-language individuals over other-language individuals (Buttelmann, Brosseau-Liard, Carpenter & Tomasello, 2012), prefer to interact with objects demonstrated by same-language speakers over different-language speakers (Kinzler, Dupoux & Spelke, 2012), and prefer to reproduce object functions demonstrated by speakers with a native accent of their language than a non-native accent (Kinzler, Corriveau & Harris, 2011).

Social learning should also be moderated by cues of benevolent intent or cues of deception. This may be a relatively minor concern for children, at least in the context of learning from an adult, since adults are probably less likely to be motivated to deceive children than to deceive each other. Yet, deception or malevolence from adult to child is possible, and a child learning information from other *children* would likely be wise to consider the possibility of trickery and lies.

An understanding of deception develops slowly: Though children as young as 2 can produce deceptive acts (Chandler, Fritz & Hala, 1989) and even preschoolers can be very convincing in their lie-telling behaviour (Lewis, Stanger & Sullivan, 1989), they still struggle in some specific circumstances. For instance, in one study where children could only get a desirable present if they concealed their preferences from a "mean" competitor, few 3-year-olds spontaneously misinformed the competitor even after repeatedly witnessing the negative consequences of telling the truth (Peskin, 1992). Young preschoolers are also typically poor at understanding many aspects of deception (e.g., Mascaro & Sperber, 2009; Winner & Leekam, 1991). For instance, children younger than 5 have difficulty inferring that someone may be lying, even when the person's claims are extremely improbable (e.g. Lee, Cameron, Doucette & Talwar, 2002). Still, children are not indiscriminately trusting: For example, preschoolers prefer to seek information from a nice individual than a mean one (Mascaro & Sperber, 2009). Children's understanding of motives underlying potential dishonesty, such as self-interest, appears to develop during mid-childhood. For example, children develop the understanding that a person is often biased in a favourable manner when attributing *to themselves* positive or negative attributes (Heyman, Fu & Lee, 2007; Heyman & Legare, 2005; Mills & Keil, 2005). Similarly, school-age children gradually come to understand other forms of bias, for instance that someone's positive or negative relationships with different individuals may influence that person's judgements and statements about these individuals (e.g., Mills, Al-Jabari & Archacki, 2012).

Evaluating the knowledge of the source of information. Children can also assess a person's potential credibility as a source of information by determining whether they are likely to be knowledgeable or not. The area of children's knowledge assessment has received a lot of attention from researchers in the past few decades. For a long time, it was believed that assessing others' knowledge was a late-developing skill. Major theoretical figures such as Piaget (1929), for instance, focused on the egocentrism of young children: He showed through several demonstrations that young children often have difficulty determining when other people's knowledge differs from their own (e.g., Piaget & Inhelder, 1956). Other research suggested that children view adults as omniscient (Mossler, Marvin & Greenberg, 1976; Wimmer, Hogrefe & Perner, 1988). Starting in the 1980s, there was enormous interest in a finding by Wimmer and Perner (1983) that preschool-age children fail at attributing to others beliefs which the children themselves know to be false. For instance, if Sally puts a marble inside a basket, leaves the room, and during her absence Ann moves the marble from the basket to a box, children younger than 4 generally claim that Sally would know that the marble was now inside the box, even if she in fact had no way of knowing about the location change (see Wellman, Cross & Watson, 2001, for a review). This finding suggested that the ability to assess others' knowledge is severely limited in very young children.

Yet, more recent research suggests that task difficulties may have led to an underestimation of children's true capacities. Subsequent experiments suggested that, in some situations at least, even infants and young preschoolers possess some ability to evaluate other people's knowledge even if they do show systematic weaknesses and biases (see below for a more detailed review of this evidence). Earlier experiments also focused on only one type of knowledge differences, typically differences due to the presence or absence of *information access* in a specific situation (for example, person A is knowledgeable about the contents of a specific box at a specific moment because she just looked inside that box; person B did not look inside the box, therefore she is ignorant of its contents). Other cues are also available that one can use: for example, people differ systematically on knowledge across situations (for example, person A is very erudite and possesses vast quantities of knowledge about the natural world, historical facts, and a variety of other topics; person B is not quite as knowledgeable). Miller (2000) referred to these two types of differences in knowledge as “situational” and “individual”; the latter will be referred to below as “person-specific” instead of “individual” to avoid confusion with the other uses of the term “individual”. Below is a review of the literature on children’s use of these different types of cues to knowledge.

Situational cues to knowledge. Individuals can differ in knowledge about a specific piece of information in a given situation. Historically, most of the literature on children’s attention to knowledge cues has focused on such situational differences in knowledge. One of the most widely studied cues to knowledge is information access. People acquire information through contact with the world, transmitted through the senses (such as seeing, hearing or feeling). A large amount of research has looked at children’s understanding of *visual* access to information. Eyes are very important in human communication, and a sensitivity to eye gaze can be detected at birth (e.g., Batki, Baron-Cohen, Wheelwright, Connellan & Ahluwalia, 2000). By 3 months, infants show some limited ability to follow another person’s eye gaze towards objects (D’Entremont, 1997), and this ability steadily increases during the first year of life (Scaife & Bruner, 1975). Infants also become gradually more sophisticated, taking into account a wider portion of the visual field and integrating things such as barriers and blindfolds (e.g., Brooks & Meltzoff, 2002; Butterworth & Cochran, 1980; Luo & Baillargeon, 2007; Moll & Tomasello, 2004). Around 9 to 12 months, infants begin to engage in joint attention, or triadic interactions with an underlying understanding of a focus of attention that is shared between the child and another individual (see Moll & Meltzoff, 2011; Tomasello, 1999). Young children frequently use others' eye gaze to make sense of their social world, for example to help figure out the intended referents of words (e.g., Baldwin, Markman, Bill, Desjardins, Irwin & Tidball, 1996; Baldwin & Moses, 1996).

As mentioned previously, early research was interpreted as showing that children were poor at using visual access to assess others' knowledge. In Piaget's classic three-mountain experiment (Piaget & Inhelder, 1956), children were shown a doll and a mountain display, and were asked to evaluate what the doll saw on the other side of the display. Children typically responded in an egocentric manner (i.e., saying the doll would see what the children saw from their own visual perspective) until they reached Piaget's *concrete operational stage*, around 6 or 7 years old. More recent studies, such as the studies mentioned above showing children's failure to attribute false beliefs to others prior to age 4, also seemed to suggest that young children have difficulty evaluating others' knowledge (e.g., Wimmer et al., 1988; see Wellman et al, 2001 for review). However, several researchers have been concerned about the demands of these experiments, and thus have sought to make simpler tasks, that demonstrated that, at least by age 3, children *can* use a person's visual access to information to infer their knowledge (e.g., Pillow, 1989; Pratt & Bryant, 1990; Robinson et al., 1999; Wellman & Bartsch, 1988). An implicit understanding of knowledge acquisition can even be found in younger children; for instance, 2-year-olds make more explicit requests for, and gestures toward, a toy to a parent who was not in the room when the object was hidden than if the parent was in the room (O'Neill, 1996).

Knowledge is, of course, not only acquired through vision, but also through hearing, touch, smell, and so on. As previously mentioned, children sometimes have difficulty distinguishing and remembering the source of their own knowledge (Gopnik & Graf, 1988; O'Neill & Chong, 2001; Robinson, Haigh & Pendle, 2008; Taylor et al., 1994). They also struggle with identifying sources of others' knowledge: For instance, preschoolers sometimes mistakenly attribute knowledge of texture or fragrance information to one who has seen objects rather than one who has felt or tasted them, or vice versa (O'Neill, Astington & Flavell, 1992). There is some evidence, however, that children's confidence in their knowledge acquired through different sources still varies depending on the quality of the source, even if they are not able to explicitly identify the knowledge source (Robinson, Haigh & Nurmsoo, 2008).

For many years, it was believed that preschool-age children possessed a rudimentary understanding of knowledge versus ignorance but were incapable of understanding that one could hold a belief that is false. Many studies have shown young preschoolers typically fail tasks requiring reasoning about false beliefs until about age 4 (See Wellman et al., 2001 for a review). Importantly, younger children do not perform at chance in these tasks, but rather *below* chance (i.e., they systematically predict that an individual will act based on the true state of affairs, or the child's own knowledge state, rather than on a false belief). This has been interpreted as suggesting that, before the age of 4, children believe that the mind holds a copy of reality, and that around age 4 they undergo a change in their conceptual understanding of minds and realize that beliefs do not necessarily correspond to reality. This view is known as the *conceptual change* account of theory of mind (Gopnik & Wellman, 1994; Perner, 1991).

This conceptual change interpretation has been questioned on many fronts. Many researchers have posited that the executive demands of false belief tasks were responsible for children's failure. Specifically, children need to keep information of relatively complex and unfamiliar scenarios in mind, inhibit over-rehearsed tendencies to point to where objects really are, and disregard more concrete aspects of the task in favour of more abstract representations, to name just a few of the potential executive limitations (e.g., Carlson & Moses, 2001; Frye, Zelazo & Palfai, 1995; Moses, 2001). False-belief task performance is indeed correlated with executive function (Carlson & Moses, 2001; Carlson, Moses & Breton, 2002). Part of the difficulty with the false belief task can be accounted for by a difficulty for children to ignore their own knowledge of the object's location (Birch & Bloom, 2003). Furthermore, children who fail false belief tasks also tend to fail other tasks such as false-photograph tasks, also requiring thinking about a representation (but not a mental representation) that is different from current reality (Zaitchik, 1990). They also tend to fail other tasks measuring counterfactual thinking (e.g., Riggs, Peterson, Robinson & Mitchell, 1988). Hence, there are many possible explanations, other than the absence of a concept of belief, for young preschoolers' systematic failures on false-belief tasks and other similar perspective-taking tasks (see Chandler & Birch, 2010, for a review).

Furthermore, since the conceptual change account states that children's egocentric mistakes are due to the fact that they lack a concept of a belief that differs from reality, this account seems to imply that, once such a concept is acquired, egocentric errors would vanish. Yet, even adults makes such errors. They are, for instance, often biased by their own current knowledge when attempting to take a less-informed perspective (e.g., Birch & Bloom, 2007; Brosseau-Liard, Joubin, Wong & Birch, in prep.; Fischhoff, 1975; Keysar, Ginzel & Bazerman, 1995; Keysar, Lin & Barr, 2003; see Birch & Bloom, 2004, and Birch & Bernstein, 2007, for reviews). The effect of this kind of perspective-taking bias appears to diminish with development but not disappear altogether (e.g., Birch & Bloom, 2003; Epley, Morewedge & Keysar, 2004; Mitchell, Robinson & Thompson, 1999; Pohl & Haracic, 2005), and some studies fail to find a clear reduction of this type of bias with age (e.g., Bernstein, Atance, Loftus & Meltzoff, 2004).

Perhaps the biggest challenge for the conceptual change account of children's false belief task performance came when studies with reduced or absent verbal demands appeared to show false belief understanding at a much younger age than was thought possible for the conceptual change account. Studies using eye tracking or behavioural measures rather than verbal responses showed that children possess an implicit understanding of false beliefs in the early preschool years (e.g., Carpenter, Call & Tomasello, 2002; Garnham & Perner, 2001; Southgate, Senju & Csibra, 2007), and completely non-verbal false belief tasks relying on looking time measures or behavioural measures have shown that infants have an understanding of false beliefs well before children's second birthday (e.g., Onishi & Baillargeon, 2005; Surian, Caldi & Sperber, 2007; Buttelmann, Carpenter & Tomasello, 2009). This research thus shows that, at a very early age, children can use a person's access to information to assess their knowledge or beliefs, at least at an implicit level.

Children's understanding of information access is of course not perfect. Indeed, decades of research on children's understanding of false belief clearly show that children often have difficulty *applying* any knowledge they might implicitly possess about the relationship between information access and knowledge acquisition; the later-developing explicit understanding may be necessary for the more sophisticated applications of knowledge and belief reasoning that are needed in many social interactions.

Failures to correctly apply visual access to information can be seen in word learning: In one recent study (Brosseau-Liard & Hall, 2011), 3- and 4-year-olds applied mutual exclusivity to map a novel word to a novel object even if the person initially uttering the novel word did not see or know about the novel object (and in fact was clearly looking and pointing towards a completely different object). Children also show some other systematic biases in their understanding of visual access to information. Toddlers have difficulty, for instance, understanding that blindfolds block knowledge acquisition (Meltzoff & Brooks, 2008). In many cases, children are a bit *too* reliant on visual access to infer others' knowledge. Indeed, infants fail to understand that someone who looks away can still hear them if they are in the same room

(Repacholi, Meltzoff & Olsen, 2008). Preschoolers also overestimate the amount of information that can be gleaned from seeing a very small part of an object or a blurred picture (Bernstein et al., 2004; Taylor, 1988). Furthermore, they sometimes refuse to grant any possible knowledge to someone who lacks visual access, even if that person could still infer the correct information (e.g., Ruffman, 1996). As mentioned above, young children also have difficulty determining what type of information is acquired through each of the senses, leading to erroneous evaluations of knowledge (e.g., O'Neill et al., 1992; O'Neill & Chong, 2001). Understanding of the various relationships between information access and knowledge acquisition improves during childhood (Ruffman & Olson, 1989).

Most studies looking at children's understanding of information access have used manipulations where children were able to directly observe an individual acquiring or not acquiring knowledge. However, there are also indirect cues, for example in speech, that can allow a child to evaluate individuals' information access. For instance, some languages have grammatical constructions that specifically express the source of the information that the speaker is conveying. One study looking at such a distinction in Bulgarian found that school-age children have at least a rudimentary tendency to moderate their trust of information conveyed by others based on these grammatical constructions (Fitneva, 2001).

Though information access is probably the best situational knowledge cue, other, more indirect, situational cues to knowledge also exist. Though research on such situational cues is scarce, a few studies have shown that preschoolers are able to use a variety of indirect cues to an individual's knowledge. For example, the attentional state of an individual may be a good indicator of their ability to acquire information in a given situation. One study has found that children as young as 3 are especially likely to distrust an individual's unexpected statements if that individual appears distracted (Jaswal & Malone, 2007).

More generally, children understand that familiarity is necessary for knowledge. When explicitly told whether or not a particular individual has ever encountered a given object, preschoolers appropriately infer whether or not the individual has knowledge of certain unobservable properties of that object, such as the individual's proper name (e.g., Birch & Bloom, 2002). Even toddlers track what is new and old for a given individual and use this knowledge to help interpret an individual's communicative intention (Akhtar, Carpenter & Tomasello, 1996; Tomasello & Haberl, 2003).

Several studies have investigated children's attention to an individual's expressed confidence in a given situation[2]. Typically, confidence is correlated with knowledge: Someone who is knowledgeable is likely to state something with certainty, whereas someone who is ignorant or unsure of their knowledge is likely to state information in a hesitant, uncertain manner. Confidence can be expressed verbally: One can use terms such as "I know", "I'm sure" or "definitely" to state confidence and "I don't know", "I think", "I guess" or "maybe" to express uncertainty. Confidence can also be expressed in paralinguistic cues, such as tone of voice (e.g., a strong, crisp tone versus an upward 'questioning' inflexion at the end of a sentence) and rate of speech (fast versus slow). Finally, confidence can be expressed non-verbally through body language, such as nodding, smiling and a satisfied expression to express confidence, or shrugging of shoulders, a puzzled expression and hesitant mannerisms to express uncertainty.

Preschoolers have been shown to attend to at least some of these cues of confidence. For instance, in Sabbagh and Baldwin (2001), 3- and 4-year-olds were exposed to an individual who associated a novel label with a referent using a statement that either suggested confidence ("I

[2] Note that confidence can also be considered a person-specific trait: Some people are consistently more likely to express confidence than others. However, most research studying children's attention to confidence has investigated it as a situational knowledge cue. Thus, here I review the literature on children's sensitivity to confidence as a situational cue. How children are influenced by person-specific differences in confidence remains a question for future research.

know right where the blicket is. It's in this box, here.") or uncertainty ("I don't know what a blicket is. Hmmmm. Maybe it's in this box, here."). Children were subsequently much more likely to select the object designated by the speaker as the referent of the novel label if the speaker had been confident than uncertain (see also Sabbagh, Wdowiak & Ottaway, 2003). Similarly, one study (Moore, Bryant & Furrow, 1989) has shown that preschoolers are sensitive to semantic differences between words such as *know*, *think* and *guess* and are more confident of information acquired from someone who claims to *know* the information than to *think* or *guess*. In a study designed to assess children's sensitivity to non-verbal markers of confidence (Birch et al., 2010), 2- and 3-year-olds were presented with videos of two different individuals. One selected a novel-looking object to perform a function while displaying non-verbal cues of certainty (e.g., nodding, a satisfied expression) and the other selected a different novel-looking object to perform the same function while displaying non-verbal cues of uncertainty (e.g., shrugging her shoulders, a puzzled expression). Children subsequently preferred to imitate the actions of the confident model over the uncertain model.

Person-specific cues. A person's knowledge state in a given situation is influenced by multiple factors. Yet, across situations, there exist enduring individual differences in knowledge. Some people just know a lot more than others about a broad variety of topics; others may possess an average level of general knowledge but have specific niches of expertise (or ignorance). These individual differences cannot be appropriately evaluated based on situational cues, which are necessarily situation-specific, but rather depend on a complex combination of factors including the person's history, interests, general intelligence, aptitudes, experience and so on. These are complex attributes that are often not easily observable in the short term. Fortunately, many observable attributes correlate to some degree with individual differences in knowledge, and thus can potentially be used as person-specific cues to enduring differences in knowledge.

Some person-specific attributes tend to correlate with knowledge, even if they are not causal indicators of knowledge. Such indicators include age (all else being equal, adults are more knowledgeable than children, though there are notable exceptions) and certain markers of status or success, for example wealth or a devoted following (all else being equal, successful and high-status individuals are probably more knowledgeable than less successful ones; see Chudek, Brosseau-Liard, Birch, & Henrich, in press, for a review).

Preschool-age children understand that adults, children and babies differ in their knowledge (Taylor, Cartwright & Bowden, 1991). Children prefer to learn words (Jaswal & Neely, 2006) and rules about the proper use of certain objects (Rakoczy, Hamann, Warneken & Tomasello, 2010) from adults rather than children. Children also prefer to learn from more powerful individuals (such as an individual who is in control of the administration of rewards, rather than one who merely receives rewards; Bandura, Ross & Ross, 1963), individuals whose statements have elicited approval from others (Fusaro & Harris, 2008), and individuals to whom others preferentially attend (Chudek, Heller, Birch & Henrich, 2012).

There also exist person-specific cues that are more directly pertinent to an individual's knowledge either in general or in a specific domain. There is now an ample body of research showing that children can use cues pertaining to both general knowledge and domain-specific expertise. One way to assess someone's suitability as a source of information, for instance, is to track the accuracy of the information provided by that individual. Generally, the fact that someone has a history of providing accurate information is an informative cue indicating that this person is knowledgeable and likely to provide accurate information again in the future. Multiple studies have demonstrated that preschool-age children do attend to individuals' past accuracy and use it as a cue when deciding from whom to learn. For instance, Koenig et al. (2004) presented 3- and 4-year-old children with videotapes of two adults, one who accurately labeled a series of familiar objects and one who labeled them inaccurately. Children were then asked to identify which informant had been right or wrong, and were given the opportunity to learn novel object labels from one or the other individual. The children who successfully identified the accurate and inaccurate informants also preferred to accept labels for novel objects from the previously accurate informant rather than the previously inaccurate one.

Other studies have found that the majority of children ages 3 and up prefer to learn from a previously accurate than an inaccurate or ignorant informant (Jaswal & Neely, 2006; Koenig & Harris, 2005a; Scofield & Behrend, 2008) and track history of accuracy spontaneously without being prompted to think about who is right or wrong (Birch et al., 2008). Preschoolers remember individuals' accuracy over a period of at least one week (Corriveau & Harris, 2009b) and appear to generalize their use of this accuracy across moderately different types of information such as object functions and object labels (Koenig & Harris, 2005a) or words and grammatical forms (Corriveau, Pickard & Harris, 2011). In simplified paradigms, even two-year-olds demonstrate a rudimentary sensitivity to speaker accuracy (Ganea, Koenig & Millett, 2011; Koenig & Woodward, 2010), and infants as young as 14 to 16 months are more likely to imitate or follow cues provided by a previously accurate than an inaccurate informant (Chow, Poulin-Dubois & Lewis, 2008; Zmyj, Buttelmann, Carpenter & Daum, 2010).

Yet, past accuracy appears to be used most robustly and flexibly by children of at least 4 year of age. Indeed, while most studies find that 4-year-olds prefer to learn from a previously accurate over an inaccurate individual, for 3-year-olds findings are more variable, with some studies finding preferential learning from previously accurate individuals (e.g. Birch et al., 2008; Scofield & Behrend, 2008) and others finding limited or non-existent use of accuracy in this age group (e.g., Clément, Koenig & Harris, 2004; Koenig & Harris, 2005a). Furthermore, older preschoolers attend to the relative accuracy of individuals, while younger children fail to differentiate, in experimental situations, between an individual who has made numerous mistakes and one who has made a single mistake (Pasquini, Corriveau, Koenig & Harris, 2007). With age children become better at using the magnitude of an individual's errors, preferring to learn from someone who previously made small errors than from someone who previously made more egregious errors (Einav & Robinson, 2010).

Older preschoolers are also better than younger preschoolers at simultaneously tracking accuracy in different domains, preferring to learn information in a specific domain from an individual who has shown expertise in that domain, even if that individual has been inaccurate with other types of information (Brosseau-Liard, Claman & Birch, in prep.; Lucas & Lewis, 2011; Sobel & Corriveau, 2010). Knowledge in one area is however not equally predictive of knowledge in all other areas. Indeed, humans differ in their areas of expertise. Experts in one domain are likely to differ from non-experts in both the amount and quality of knowledge they have in a specific field, and this additional knowledge is often not transferred to other fields of knowledge (Bédard & Chi, 1992). Even infants might have some understanding of expertise: In several studies, when exposed to novel objects in an experimental context, infants are more likely to show social referencing towards the experimenter (who can be considered an "expert" in the laboratory setting) than towards their mother (e.g., Stenberg, 2009). Such findings, of course, can have multiple interpretations and do not necessarily imply that infants truly understand expertise. Preschoolers, however, do have an understanding of others' differences in expertise. Four-year-olds can, in some circumstances, use individuals' demonstrated knowledge in specific areas to decide from whom to learn new information (e.g., Sobel & Corriveau, 2010). Some differences in expertise depend on social categories, such as age, gender or occupation. A few studies have shown that preschoolers possess an understanding of age-specific areas of expertise (e.g., Fitneva, 2010). Young children may in fact be fairly good at integrating different cues to expertise: For instance, when given the choice to ask information from either an adult unfamiliar with the topic at hand or from a child described as familiar with the topic, preschool-age children will ask the child, but they will prefer to ask an adult about these topics if the adult is specifically described as more familiar with the topic than the peer (Vanderborght & Jaswal, 2009).

In terms of domain-specific expertise, Lutz and Keil (2002) have shown that 3- to 5-year-olds understand the expertise domains of highly familiar occupational categories, such as doctors and car mechanics; however, children have more difficulty reasoning about the knowledge of unfamiliar types of experts (e.g., an "eagle expert"). It takes a few more years still for children to grasp the difference between expertise areas that adults believe to be unrelated, such as the moral and scientific domains (Danovitch & Keil, 2007). Overall, children do not spontaneously use more sophisticated knowledge-clustering strategies (e.g., clustering knowledge based on underlying principles) until late in the school-age years (Danovitch & Keil, 2004; Keil, Stein, Webb, Billings & Rozenblitz, 2008).

Using knowledge cues.

The research described above suggests that children can attend to a variety of knowledge cues. Yet, the fact that children can understand a cue does not automatically imply that they will use this cue in all situations where the cue might possibly be relevant. The section below summarizes literature that has investigated variations in children's use of different knowledge cues.

Multiple knowledge cues. The evidence reviewed so far suggests that preschool children can use both person-specific and situational cues to correctly assess another person's knowledge, albeit not without systematic errors and weaknesses. However, in everyday situations, cues are not presented in isolation. Rather, multiple cues may be relevant in a single situation. The best way to integrate multiple cues depends both on the cues and on the situation. In some cases, it may be wise to take into account all available cues; in other cases, some cues are much more relevant or more informative than others.

Often, different indicators of knowledge converge on the same conclusion and complement each other. For instance, a person who has not had relevant information access will probably provide a guess in a manner suggesting lack of confidence. In such a case, there is no ambiguity as to whether to trust the person or not, and the child could use either cue to arrive at the same conclusion. However, in some situations, cues may conflict. Children can be faced with conflicting person-specific cues: for instance, an adult could be labeled an “expert” on a topic and yet have made mistakes in the past. Children could also encounter conflicting situational cues: a person could have limited visual information but appear confident. In some situations, person-specific and situation-specific cues may also conflict, for instance if someone has a history of inaccuracy and yet possesses relevant perceptual information.

What happens when children have a choice of cues from which to derive their evaluations of knowledge? One possibility is that children will preferentially use some cues over others. Some cues may be more salient or easier to understand, and hence be distinguished faster and more often than competing cues. It may be simpler, especially for young children with limited processing abilities, to build a judgment of knowledge on the most noticeable cue than to look for the best or most appropriate cue. A second possibility is that children could make appropriate evaluations of the cues that are most likely to affect future accuracy, and hence decide on a case-by-case basis which indicator is most relevant in a given situation. This would result in a remarkable situational flexibility in children’s use of diverse cues.

Unfortunately, there is currently very little research on children's weighing of different knowledge cues. The little research that does exist suggests that children may be able to appropriately integrate different cues to knowledge in some circumstances. For instance, as mentioned above, although preschool-age children can use age as a cue to knowledge, they disregard age if other cues that are more predictive of knowledge, such as history of accuracy or visual access to information, are available (Jaswal & Neely, 2006; Pillow & Weed, 1997). They can even use age in different ways depending on the relationship between age and expertise in a particular domain (Fitneva, 2010; Vanderborght & Jaswal, 2009). Yet, children do not always use competing knowledge cues in the most savvy way: For example, 5- and 6-year-olds, unlike adults, fail to realize that it may be wisest to trust a confident individual if that individual has previously only been confident when they were actually knowledgeable than if that individual is always confident regardless of their knowledge state (Tenney et al., 2011).

As mentioned above, young children tend to put a lot of weight, sometimes too much, on visual access; however, this may stem from a lack of explicit understanding of the limits of vision and poor metacognitive awareness. Sometimes, in fact, granting greater importance to visual access than other cues is a good strategy. For example, one series of studies by Taylor et al. (1991) demonstrates that, though 4- and 5-year-olds generally believe that adults are more knowledgeable than children and babies, they do not believe that an adult gains more knowledge than a child from the same amount of visual access to a picture. In these studies, however, children failed to realize that, due to immaturity and a lack of general knowledge, a baby would be unable to interpret visual information in the same way as older children or adults.

Children's ability to appropriately utilize different knowledge cues may be tied to specific details of the learning situation. As an example, there are studies indicating that children disregard an individual's past accuracy if it was due to lack of information access (e.g., she only got to feel an object not see it, so she did not know its color) and if the individual is subsequently given appropriate information access (e.g., Nurmsoo & Robinson, 2009a; Robinson & Whitcombe, 2003). However, if an informant mistakenly labels objects while blindfolded, children still consider this informant unreliable on future trials when the blindfold is removed (Nurmsoo & Robinson, 2009b).

In summary, although there is some evidence that children can be flexible in their use of different cues when multiple indicators of knowledge are available, the picture provided by this evidence is yet incomplete, and cannot provide a definite assessment of whether the use of different cues is driven by a preference for some cues or by a judgment of their relative importance. Research presented in this dissertation will provide more information on this question, as outlined in the section below titled “Overview of program of research”.

Generalization of knowledge across situations. When children have picked up on one knowledge cue in a specific situation, they still have to decide what other situations that knowledge cue may apply to. This should depend on the cue at stake: situational cues should not be generalized across situations, whereas person-specific cues often should be. Still, even within these broad categories, there can be differences in how appropriate it is to assume that a previously demonstrated knowledge cue applies to a new situation.

Children’s generalization of knowledge could be affected by their broader propensity for generalization (or lack thereof) of person-specific dispositions. There is evidence that children can make attributions of person-specific characteristics in infancy: For example, a series of studies by Hamlin and colleagues suggested that infants form preferences towards actors who act in a prosocial manner and dislike actors who act in an antisocial manner (e.g., Hamlin, Wynn & Bloom, 2007; Hamlin & Wynn, 2011; Kuhlmeier, Wynn & Bloom, 2003). Similarly, the attachment literature suggests that children form expectations of another person’s disposition and behaviour based on past interactions, at least when that person is their primary caregiver (Bowlby, 1958); infants may even generalize expectations from that relationship to other parent-infant pairs (Johnson, Dweck & Chen, 2007; Johnson, Dweck, Chen, Stern, Ok & Barth, 2010). However, there are developmental changes in the breadth and nature of children's dispositional attributions during childhood.

Adult social psychological literature is replete with examples of disposition generalization, even sometimes *excessive* generalization. Two social psychology phenomena, the *halo effect* and the *fundamental attribution error*, are symptoms of this overgeneralization. The halo effect refers to a commonly-occurring phenomenon where upon witnessing an individual displaying one positive characteristic, people are likely to assume that the individual also possesses other unrelated positive attributes. This effect has been mostly studied for attractiveness, with findings from adults (e.g., Dion, Berscheid & Walster, 1972) and preschoolers (e.g. Dion, 1973; Ramsey & Langlois, 2002); however, similar effects are also found with other attributes of positive or negative valence, including psychological attributes (e.g., Benenson and Dweck, 1986; Nabors & Keyes, 1995; Nowicki, 2006; Stipek & Daniels, 1990). As an example (Cain, Heyman & Walker, 1997), one series of experiments with 4- and 5-year-olds has shown that children expect individuals described as nice to perform more prosocial behaviour in the future than individuals described as mean; yet, they also expect nice individuals to display an advantage in intellect and athletic performance (though this predicted advantage is much smaller than that predicted for prosocial behaviour).

The fundamental attribution error (Ross, 1977) refers to the tendency for individuals, when presented with a sample of a person's behaviour, to assume that this behaviour reflects the person's underlying disposition (as opposed to situational factors). Such a bias potentially leads to an overzealous assumption that one could predict the person's future behaviour based on a sample of their past behaviour. However, as pointed out by Harvey, Town and Yarkin (1981), that people are biased towards dispositional attributions does not mean that they are usually inaccurate, as dispositions do predict behaviour. Hence, such a bias may be useful in everyday life for the simple reason that it serves to keep a mental tally of others' behaviour and thus potentially increase predictive accuracy in the long run.

Young children's explicit attributions of stable dispositions are, however, much more narrow and fragile than those of adults. During early childhood, the tendency to attribute psychological traits or consistent dispositions and use them to predict behaviour is weak (Heller & Berndt, 1981; Kalish, 2002; Kalish & Shiverick, 2004; Liu, Gelman & Wellman, 2007; Rholes & Ruble, 1984), though it can be elicited in certain contexts (e.g., Boseovski & Lee, 2006; Heyman & Gelman, 1992; Kushnir, Xu & Wellman, 2008; Seiver, Gopnik & Goodman, in press). When they do make disposition attributions, young children appear biased to attribute positive traits to others, sometimes even when presented with substantial evidence of negative behaviour (e.g., Boseovski & Lee, 2008; Boseovski, Shallwani & Lee, 2009; Schuster, Ruble & Weinert, 1998). With increasing age, children become more likely to use past behaviour for trait attribution and do so in a more sophisticated way (Liu et al., 2007; Newman, 1991; Rholes & Ruble, 1984; Schuster et al., 1998). Propensity for trait attribution may in fact be a product of cultural learning: There are studies suggesting that adults from non-Western cultures are more likely than Western adults to interpret others' behaviour in terms of situational factors rather than dispositional tendencies (Choi & Nisbett, 1998; Choi, Nisbett & Norenzayan, 1999; Miller, 1984; Morris & Peng, 1994).

One may wonder why young children appear conservative or impoverished in their attributions. There is in fact substantial literature on people's general propensity to transfer information from one situation to another, suggesting that this may be a difficult task at all ages (see for instance Barnett & Ceci, 2002). Hence, young children's weakness at dispositional attributions may be due to a general difficulty with knowledge transfer across situations.

With specific regard to the generalization of knowledge cues, general findings on children's weak disposition attributions, as well as the previously mentioned tendency for young children to trust by default (e.g., Jaswal et al., 2010), may lead one to expect that knowledge cues would be used in a very narrow way early on and in a broader way with increasing age. Yet, one would hope that, when children do generalize knowledge cues, they do so in a way that is sensible depending on the specific knowledge cue they are using and the type of information they are learning.

In some cases, it is appropriate to refrain from generalization. For instance, situational cues to knowledge should not be generalized from situation to situation, and there is indeed evidence that children do not as a rule generalize visual access (e.g., Nurmsoo & Robinson, 2009a) or confidence (Birch, Akmal, Vauthier & Frampton, 2008) across situations. Person-specific cues, however, are generally likely to predict knowledge in several – but not all – situations. At the very least, infants and preschoolers can generalize cues such as past accuracy across similar learning situations, where the type of information being learned is very similar in nature to that for which individuals demonstrated accuracy or inaccuracy. In terms of generalizing across different *types* of knowledge, however, evidence is mixed. Very early in development, one study has found that toddlers do not use demonstrated knowledge of object functions to decide whose object preferences to follow (Zmyj et al., 2010); no study, however, has investigated generalization between different types of knowledge (rather than from knowledge to preferences) in children this young. Preschool-age children appear to generalize accuracy across moderately different areas of knowledge, at least when prompted to explicitly think about who was right or wrong (e.g., Koenig & Harris, 2005a). One study has shown that 5-

year-olds, but not 4-year-olds, use past accuracy to make explicit attributions of knowledge in different areas and attributions of traits with positive or negative valence (Brosseau-Liard & Birch, 2010). Five-year-olds do not, however, systematically distinguish domains of expertise that adults and older children believe to be unrelated, for instance moral versus factual expertise (Danovitch & Keil, 2007). Lutz and Keil (2002) found that 3-year-olds have great difficulty using information about an individual's expertise to predict their knowledge in domains slightly outside their area of expertise (for instance, they have no intuition about who, between a doctor and a car mechanic, is most likely to know how to fix a lawnmower). Older preschoolers are better at this type of generalization, although a more complex understanding of how knowledge clusters and generalizes across domains develops during the elementary school years (e.g., Danovitch & Keil, 2004, 2007; Keil et al, 2008).

In sum, apart from generally demonstrating a broader and more sophisticated use of knowledge cues with increasing age, past studies provide fairly fragmented information about the breadth of children's use of person-specific knowledge cues. There is no clear indication of broader theoretical factors that may moderate whether or not children generalize from one context to another. This is an area that the studies presented in this dissertation aim to explore further as outlined below.

Overview of program of research

As explained in the previous section, research investigating factors moderating children's use of knowledge cues is currently quite limited. The research program described below aims to fill this gap in the literature. As a complete investigation of the factors moderating children's use of knowledge cues would be beyond the scope of any single dissertation, the experiments described in the current dissertation necessarily focus on just a few aspects of this broad question. Specifically, these experiments investigate preschool and young school-age children's use of the cue of past accuracy, and focus primarily on factors moderating children's use of individuals' past accuracy when learning different types of information. This research program is divided in three parts, outlined below.

Children's generalization of informants' past accuracy: Narrow, broad or savvy?

Chapter 2 explores the issue of children's generalization of individuals' accuracy across different types of information. As mentioned above, evidence pertaining to children's generalization of accuracy in the preschool period is currently somewhat ambiguous. A few studies have shown that preschoolers can generalize an individual's accuracy between somewhat related types of information (e.g., Corriveau et al., 2011; Koenig & Harris, 2005), but the spontaneity and breadth of this generalization are unclear. Given studies showing that young preschoolers have a strong bias towards trust (Jaswal, 2010; Jaswal et al., 2010) and show little *explicit* generalization of knowledge (e.g., Brosseau-Liard & Birch, 2010), one might expect that a tendency to generalize the use of individuals' (in)accuracy between different types of information would be fragile at first and develop more robustly during the preschool years.

Experiments 1 to 3 investigate 3- and 4-year-olds' use of past accuracy demonstrated with one type of information (i.e., the stated functions of common objects) when learning a variety of other types of information, some objective (e.g. category-level labels for objects) and some subjective (e.g. stating which foods are tastier). Three accounts for generalization are contrasted: A "narrow" pattern, or no generalization beyond the immediate type of information; a "broad" pattern, or indiscriminate generalization across all types of information; and a "savvy" pattern, or generalizations based on principled distinctions in the type of information. In this case, the principled distinction of interest is operationalized as objectivity or subjectivity of the information, because this is a distinction that even young preschoolers are sensitive to, at least at an implicit level (Flavell, Flavell, Green & Moses, 1990). Hence, a "savvy" pattern of generalization in this series of experiments implies generalizing across objective types of information but not from objective to subjective information. This provides a first test of whether preschool-age children can make principled distinctions between information types in their generalization of accuracy and use them as a cue to guide social learning.

Factors moderating children's generalization of an informant's accuracy: Type of information and presence of an indirect social source.

Chapter 3 investigates whether children's generalization of accuracy is influenced by another principled distinction within areas of objective knowledge, namely between information that is *generalizable* – information that typically applies to more than one member of a category or to more than one situation – and *idiosyncratic* – information that applies to a single individual or instance. Examples of generalizable information include category-level labels and rules pertaining to object use. Examples of idiosyncratic information include the current location of a specific object, ownership information, and transient physical properties (e.g., the fact that an object has a price tag stuck to it). In Experiments 4 and 5, children ages 4 to 7 are presented with one individual who demonstrates either accuracy or inaccuracy about generalizable information. Children are then presented with a situation where they can choose to learn from that individual. In Experiment 4, the information that they are learning is always generalizable in nature. In addition, for some children, this information is of the *same type* in terms of subject matter as that presented in the individual's accuracy demonstration, hence not necessitating any generalization across types of information; for other children, the information is also generalizable but of a *different type* than that presented in the accuracy demonstration. In contrast, in Experiment 5, the information learned at test is idiosyncratic. Knowledge of idiosyncratic information is highly dependent on information access and not on general knowledge. Therefore, the predictive value of an individual's past accuracy with generalizable information for assessing their knowledge of idiosyncratic information is extremely low. Research shows that children as young as 4 are sensitive to differences between generalizable and idiosyncratic information when deciding for which instances of a category a certain piece of information is applicable, but they improve in this distinction by age 7 (e.g., Gelman, 1988). Experiments in Chapter 3 will ascertain whether children use this distinction to moderate their generalization of an individual's past accuracy in learning situations.

In addition, these two experiments add another feature rarely included in studies of children's use of knowledge cues, namely the availability of a source of information (i.e., a visual clue from a computer) that is not a person or a 'person surrogate', such as a puppet or cartoon character. So far, experiments testing children's use of informants' past accuracy in a learning situation have only given children the option of learning from one or more individuals. As mentioned earlier, direct social learning is extremely useful for children and can represent an enormous improvement over what children would be able to learn on their own. Yet, children still do learn through other means. In some situations, for instance, children can access readily available information in the world around them; in other situations, children have access to information that comes to them through an indirect social source (e.g., books or media that have contents created by people). However, even in a case where there is an accessible source of information other than an individual and this source is described as always being correct, children may still choose to seek information from an individual. For instance, there are other benefits to establishing a 'relationship' with another individual and favoring a social source over a non-social or indirect social source. However, this trade-off may only be worthwhile if the person is likely to be accurate. Experiments in Chapter 3 will thus investigate whether children's propensity to seek out information from an individual is moderated by that individual's previously demonstrated accuracy even when an alternate source of knowledge is available.

Epistemic states and traits: Children's differentiation of situation-specific and person-specific knowledge.

In Chapter 4, I further explore children's use and generalization of informants' accuracy when learning idiosyncratic and generalizable knowledge. As mentioned above, past accuracy, which can be taken as an indicator of general knowledge and/or expertise in a given area, is likely a useful predictor of generalizable knowledge, or knowledge as a *trait* (e.g., is person X a generally knowledgeable person? Does person X possess expertise in a given area?), but not of idiosyncratic knowledge, or knowledge as a *state* (e.g., is person X currently knowledgeable about a specific fact pertaining to a specific instance?). Experiment 6 thus tests whether children are more likely to use information about individuals' past accuracy when they learn generalizable information from these individuals than when they learn idiosyncratic information. In this experiment, 4- and 5-year-olds witness two informants differing in accuracy in their reference to common objects. For some, the informants demonstrate either a history of accuracy or inaccuracy at providing *generalizable* information about the objects (i.e., the objects' category-level labels), and for others, the informants demonstrate either a history of accuracy or inaccuracy at providing *idiosyncratic* information about the objects (i.e., visually identifying which of the common objects is currently inside a box). Subsequently, children are told information pertaining either to novel object labels (generalizable information) or to the location of novel objects (idiosyncratic information). Importantly, the type of information (labels or location) during the history and at test is crossed. If children are sensitive to the fact that past accuracy is a better predictor of future knowledge of generalizable information (or knowledge as a *trait*) than of future knowledge of idiosyncratic information (or knowledge as a *state*), they should be more likely to use past accuracy when learning object labels than when learning about object locations.

Of course, idiosyncratic knowledge can be accurately predicted by other types of knowledge cues. Specifically, visual access to information is a good predictor of an individual's knowledge *state* about a specific piece of information. In Experiment 7, 5-year-olds witness informants differing in both past accuracy (again, either about object labels or the identity of hidden objects) and in visual access to the test objects. In some trials, accuracy and visual access provide congruent answers about whom to trust (i.e., the previously accurate individual is visually-informed and the previously inaccurate individual is visually uninformed); in other trials, the knowledge cues provide conflicting information (i.e., the previously inaccurate individual is currently visually informed and the accurate one is visually uninformed). This experiment investigates the relative strength of these two knowledge cues for the learning of idiosyncratic and generalizable information. If children are sensitive to the different predictive value of these two knowledge cues, they should favour visual access when learning idiosyncratic information but use both cues when learning generalizable information.

Chapter 2. Generalization of informants' past accuracy: Narrow, broad or savvy?

Introduction

As humans, we depend greatly on information gleaned from others. The social structure of our species renders the acquisition and sharing of information extremely valuable. Yet, the value of information learned from others depends in great part on its accuracy. It is thus advantageous to learn from others but find ways to evaluate the potential veracity of information.

One tool for doing this is to evaluate the extent to which the source of the information is knowledgeable. Of course, being knowledgeable can mean many things: One can be a "knowledgeable" individual across a wide variety of areas, or be "knowledgeable" in a certain niche of expertise, or know a specific fact. In some cases, knowing that an individual is knowledgeable (or not) about a specific type of information (e.g., physics) allows one to make inferences about their knowledge of other types of information (e.g., mathematics); in other cases, such inferences are unwarranted (e.g., someone being knowledgeable about physics is not very informative about whether that person will also be knowledgeable about professional baseball). The present paper investigates what types of knowledge attributions preschool children make about individuals following evidence that these individuals differ in their knowledge in one specific area.

Although one cannot directly observe the knowledge present in others' minds (as this would require telepathy), one can use various cues to evaluate the credibility of different individuals. Past research has shown that children can track many such cues and use them to moderate their trust in different informants (see Corriveau & Harris, 2010, Harris, 2007, Heyman, 2008, and Nurmsoo, Robinson & Butterfill, 2010 for reviews). Children can, for instance, track the accuracy of different individuals over time and preferentially learn from those who tend to provide accurate information. For example, in a study by Koenig, Clément and

Harris (2004), 3- and 4-year-olds were presented with videos of two individuals, one who accurately labeled a series of common objects and one who repeatedly mislabeled the same objects. Children subsequently preferred to learn novel labels from the previously accurate individual over the previously inaccurate individual. Many studies have replicated this finding using variations on this paradigm (e.g., Birch, Vauthier & Bloom, 2008; Corriveau & Harris, 2009; Jaswal & Neely, 2006; Mills, Legare, Grant & Landrum, 2011; Nurmsoo & Robinson, 2009; Scofield & Behrend, 2008) and with even younger children (Chow, Poulin-Dubois & Lewis, 2008; Koenig & Woodward, 2010; Zmyj, Buttelmann, Carpenter & Daum, 2010). Children's attention to accuracy is not limited to the learning of object labels, but is also present for the learning of other aspects of language (Corriveau, Pickard & Harris, 2011), object functions (Birch et al, 2008; Koenig & Harris, 2005), norms and rules (Rakoczy, Warneken & Tomasello, 2009), and events (Fitneva & Dunfield, 2010).

Little attention has been given, however, to whether children generalize their use of an informant’s accuracy beyond a single type of information. If children witness Model A being accurate about the functions of common objects and Model B being inaccurate about the functions of common objects, what inferences, if any, do children make about the models’ knowledge of other types of information? The goal of the research presented in this chapter is to investigate this question.

In general, there are three different possible patterns of generalization of accuracy. Under one pattern, that we refer to here as “narrow”, children may generalize between different situations within the same type of information or category of knowledge, but not across different types of information. For example, someone who has been accurate about object labels is expected to keep being accurate about object labels in other situations, but no expectations are built about their accuracy with other types of information. As mentioned above, previous studies have shown that preschoolers can generalize accuracy across situations involving the same kind of knowledge (e.g., labels or language), but do not address whether, or to what extent, children expect their informants' prior accuracy in one area to generalize to different types of knowledge (with a few possible exceptions discussed below).

We refer to a second possible pattern as "broad", or indiscriminate, generalization. Under this pattern, children would generalize one's prior accuracy across all possible types of information. For example, a child, witnessing someone being accurate about object labels, will subsequently trust that person not only about object labels, but about all other sorts of information, related or not – such as information about both the physical world and the social world, and be it objective or subjective.

Finally, we refer to a third possible pattern as "savvy": Under this pattern, children would build expectations about individuals' accuracy in related areas, but would refrain from making inferences about a person's knowledge in areas perceived as substantially different from the information type for which they witnessed that person being accurate (or inaccurate). What constitutes 'related' or 'substantially different' information is not easily defined. There are many ways in which knowledge can be perceived to cluster in the minds of others (e.g., by topic versus by underlying principles; see Keil et al., 2008). The extent to which it is reasonable to use an individual's knowledge in a given area to make inferences about his or her likely knowledge of another area will depend greatly on the particular areas in question. For example, knowing that Frank is knowledgeable about biology should be more apt to incite inferences that he will also know about chemistry than baking. Our goal for the present studies was not to examine all of the ways children generalize one's prior accuracy (that would be beyond the scope of any single set of studies), but rather to make inroads into this line of inquiry using a selective social learning paradigm by asking two key questions: First, do children who have witnessed an informant's accuracy in one area *ever* use that information to judge that informant's knowledge outside of that immediate domain[3]? Second, if young children do generalize one's knowledge of one type of information to others, do they ever *refrain* from generalizing or do they generalize to all kinds of information indiscriminately?

One may expect that generalizations of knowledge would be fragile or absent in young preschoolers given that several studies have shown that they have difficulty attributing trait-like psychological constructs to individuals who display behavioural regularities (e.g., Kalish, 2002; Rholes & Ruble, 1984). In contrast, older preschoolers and school-age children – and, in fact, adults too – tend to overgeneralize, believing for instance that someone who possesses one positive attribute (e.g., being nice) will also show other positive attributes, such as being smart or talented (e.g., Benenson & Dweck, 1986; Brosseau-Liard & Birch, 2010; Cain, Heyman & Walker, 1997; Stipek & Daniels, 1990). This is often referred to as the *halo effect*. As children get older, then, they typically make more trait generalizations. Still, it is uncertain whether they would generalize appropriately (e.g., informed by the relatedness of the types of information) or, in line with the halo effect, generalize indiscriminately across all types of information.

Importantly, some studies indicate that preschoolers have a rudimentary understanding of domain-specific expertise, hence suggesting that they might have the capacity for distinguishing types of information for which generalization is warranted versus those for which it is not. Preschoolers can, for instance, distinguish between biological and mechanical knowledge (e.g., Lutz & Keil, 2002). Similarly, children at least 4 years old can appropriately infer whom to ask for information based on individuals' specialized knowledge of different types of information (e.g., Mills, Legare, Bills & Mejias, 2010). Still, children's understanding of how knowledge

[3] Herein, the term 'domain' simply denotes a particular category of knowledge or type of information. Its use here should be distinguished from its uses in the literatures on 'domain-specific learning' and 'core-knowledge domains'.

tends to cluster in the minds of others improves greatly during the preschool- and school-age years. For example, although 4- and 5-year-olds can infer which of two familiar types of experts (doctors or car mechanics) possesses knowledge necessitating an understanding of biological or mechanical principles, they have more difficulty inferring which of two unfamiliar types of experts (i.e., an "eagle expert" and a "bicycle expert") would possess either biological or mechanical knowledge (Lutz & Keil, 2002). Also, preschoolers and young elementary-school children understand expertise based on topic but only later do children consistently cluster knowledge according to unifying principles that tend to characterize academic disciplines (Danovitch & Keil, 2004; Keil et al., 2008).

If preschoolers generalize accuracy across some types of information, it is likely that the degree to which they generalize will be driven by whether *they view* the types of information as being related. In other words, whether knowledge of the different types of information correlates in the real world may matter little here; it is children's current understanding of the potential relatedness between types of information that will drive their tendency to generalize. Hence, the extent to which preschoolers generalize from one type of knowledge to another affords us a unique window into their understanding of how knowledge tends to cluster in the minds of others.

One important distinction that children make fairly early in development (at least at an implicit level) is between *objective* and *subjective* information. One study has found that, though children can explicitly state their understanding of the distinction between facts and opinions around the age of 10, they use that distinction to moderate their learning much earlier (Banerjee, Yuill, Larson, Easton, Robinson & Rowley, 2007). Another study found an implicit understanding of the distinction in children as young as three: Although children of that age typically fail explicit tasks involving reasoning about others' false beliefs about objective facts (for example, believing a milk carton is full when it is in fact is empty), they are much more successful at understanding that another individual can hold a different view of a subjective fact, such as believing a cookie tastes bad when the child finds it tasty (Flavell, Flavell, Green & Moses, 1990).

It remains to be investigated whether preschoolers are also sensitive to the distinction between objective and subjective information when they decide whether or not to use individuals' past accuracy to moderate their social learning. Some studies have shown that, from infancy, children can be influenced in their subjective food choices by other people's behaviour and characteristics such as "niceness" or "meanness" (e.g., Hamlin & Wynn, 2012). Yet, objective knowledge is an individual characteristic that one probably *should not* consider relevant when deciding whether or not to trust someone's food preferences. For instance, upon witnessing a person demonstrate their expertise in a scientific discipline, one's intuition may be that this person's claims about related scientific fields and possibly about general knowledge are likely trustworthy; however, one would likely hesitate to blindly let that individual order one's meal at a restaurant. Knowledge of objective information is simply not a very good predictor of correspondence between two people's subjective food preferences. It is currently unknown whether preschool-age children have this intuition or whether, in a manner reminiscent of the halo effect, they would similarly favor a more knowledgeable individual (or mistrust an ignorant individual) in a subjective domain. Interestingly, at least one study (Zmyj et al., 2010) has shown a *lack* of generalization from accuracy in one objective knowledge domain (object functions) to a domain that incorporates a degree of subjectivity (object preferences). However, children in this study were only 14 months, thus leaving open the possibility that skills at generalization develop later or that they are reluctant to generalize from accuracy in an objective domain to a more subjective domain.

As for generalization between different types of objective knowledge, evidence so far is limited. Two recent studies (Brosseau-Liard & Birch, 2010; Fusaro, Corriveau & Harris, 2011) suggest that, before 5 years of age, children who witness individuals differing in accuracy about the labels for common objects can use this accuracy to make *explicit* attributions of those individuals' knowledge (or lack thereof) of other words, but do not explicitly generalize beyond word knowledge. It is quite possible, however, given the many notable distinctions between implicit and explicit processes, that children build the implicit expectation that two individuals will differ in knowledge across a variety of domains without being able to verbalize this expectation. In fact, past studies have found that preschoolers sometimes use information about individuals' knowledge in a learning situation even though they fail explicit source-monitoring questions (e.g., Robinson, Haigh & Nurmsoo, 2008; Whitcombe & Robinson, 2000).

A few recent studies even appear to suggest that preschool-age children can generalize accuracy across learning situations involving somewhat different types of information. In one series of studies (Corriveau et al., 2011), preschool-age children used individuals' accuracy in one aspect of language (labeling objects) to decide whether to learn other aspects of language (i.e., grammatical forms) from them. In Sobel and Corriveau (2010), children used individuals knowledge of different types of object properties to reason about individuals' knowledge of labels for the same objects. Finally, one pair of studies (Koenig & Jaswal, 2011) investigated 3- and 4-year-olds' generalization of expertise across different types of labeling situations. In a first experiment, children did not prefer to learn labels for artifacts from a "dog expert" over a non-expert (but accurate) individual. In a second experiment, one individual made neutral statements about dogs (e.g., "that's a nice one") whereas the other individual was shown to be especially ignorant about dogs (and presumably about cats too, as that individual repeatedly mislabeled dogs as different kinds of "cats"). The experimenter also emphasized the inaccurate individual's ignorance about dogs, explicitly stating that the individual “does not know much about dogs” and “knows less about dogs than anyone I know”. Children subsequently preferred to learn both dog breed labels and artifact labels from the neutral individual over the inaccurate labeler.

The aforementioned findings suggest that preschool-age children can generalize accuracy across some types of knowledge; however, these past studies primarily investigated generalization between very closely-related types of information. Some studies assessed generalizing between two situations involving language learning, either from labels to grammatical forms (Corriveau et al., 2011) or from providing labels for animals to providing labels for artifacts (Koenig & Jaswal, 2011). Another study tested generalization of knowledge between different properties of the same objects (Sobel & Corriveau, 2010). These findings leave open the question of whether children generalize (in)accuracy across more dissimilar types of information.

To our knowledge, the only study that has tested broader generalizations is one by Koenig and Harris (2005a, Experiment 3) that presented 3- and 4-year-olds with one informant who consistently provided the correct label for common objects and a second informant who repeatedly claimed ignorance of the labels. Subsequently, children preferred to learn both new labels and new object functions from the previously accurate labeler over the ignorant individual. However, this study, as well as those by Koenig and Jaswal (2011), used procedures that leave open the question of whether children’s generalizations of accuracy in these studies were spontaneous or driven by specific aspects of the experiment. For instance, in Koenig and Harris (2005a), children were always presented with label learning trials *before* function learning trials. The demonstrated tendency to generalize could have been influenced by the previous presentation of same-domain learning trials (i.e., children may have simply perseverated and chosen the same source of information that they had already selected on same-domain trials).

Furthermore, children were prompted, before any of the learning trials, to explicitly think about and state which individual was "not very good at answering questions". Either the prompt to explicitly think about who was 'not very good…' or the domain-general nature of the statement (i.e., "not very good at answering questions" as opposed to something like "did not correctly answer the questions about what these things were called") may have prompted children to attribute knowledge (or ignorance) as enduring *traits* to the informants. Indeed, recent findings by Fitneva and Dunfield (2010) show that preschool-age children's use of individuals' accuracy can be substantially influenced by such explicit prompts. In their studies, two individuals each provided a single piece of information about an event that was either correct or incorrect. Participants then could choose one informant from whom to learn another piece of information about the same event. Adults and 7-year-olds systematically chose the accurate informant across three experiments, whereas 4-year-olds only did so after being prompted to tell the experimenter which of the informants was "very good/not very good at answering questions". Hence, studies using explicit prompts before learning trials show that preschool-age children *can* generalize accuracy across certain types of information at least with some social scaffolding but do not indicate whether such generalizations occur spontaneously. To us, children's spontaneous inferences of how others' knowledge will generalize is of the utmost interest because it is their spontaneous inferences that will ultimately guide their day-to-day learning.

The present studies were designed to address these open questions in the literature: Do young children *spontaneously* make inferences about what other information their informants' are likely to know based on their informants' prior knowledge in a given area? Will young children generalize one's prior accuracy to more *disparate* types of information than previously established? Will the nascent understanding of expertise that has been demonstrated using explicit knowledge assessment tasks (e.g., Danovitch & Keil, 2004; Lutz & Keil, 2002) manifest itself in children's social learning preferences? More specifically, we aimed to determine which of the three patterns described earlier (narrow, broad or savvy) best represents 3- and 4-year-olds' generalizations of others' prior accuracy in a selective social learning paradigm. One might expect a developmental trend towards greater generalization with increasing age given that both the understanding of how different types of knowledge relate and the tendency to make broad trait-like inferences increase with age. Moreover, given that the understanding of the distinctions between different types of knowledge improves with age, one might also expect that older children would be more likely to demonstrate the "savvy" pattern of generalization rather than generalizing indiscriminately.

To focus the scope of our studies, we kept the type of information for which informants demonstrated their prior knowledge constant across all three experiments. Specifically, informants differed in their accuracy at stating the functions of common objects. We chose this type of information for the following reasons. First, given that the majority of studies on children's use of individuals' accuracy have examined accuracy at *labeling*, including the studies that have begun to address children's generalizations of one's prior knowledge (e.g., Corriveau et al., 2011; Koenig & Harris, 2005a; Koenig & Jaswal, 2011), it is important to use a different type of information to ensure that the phenomenon is not specific to labeling. Second, we wanted to use a type of knowledge for which children's ability to use past accuracy had already been established. Previous studies have demonstrated that preschoolers (and even toddlers) can attend to and use past accuracy about object functions (e.g., Zmyj et al., 2010; Birch et al., 2008), so we modelled our studies after this work to address our research questions.

In three experiments, two individuals were shown to differ in accuracy at stating the *functions* of familiar objects. Experiment 1 first tested children's likelihood of generalizing this accuracy (or inaccuracy) to a different domain (learning the *labels* for new objects). Experiment

2 included additional types of information to further probe children's proclivity to generalize individuals' accuracy across domains. Experiment 3 specifically contrasted an objective domain (object labels) with a subjective domain (taste of novel foods).

Experiment 1

This experiment was modelled after the experiments in Birch et al. (2008), where 3- and 4-year-olds spontaneously tracked individuals' relative accuracy about both object labels (Experiment 1) and object functions (Experiment 2). In these past studies, children's use of accuracy was tested within-domain, demonstrating that children use informant accuracy for both object labels and object functions but not addressing whether children believe that accuracy in one area is predictive of accuracy in another area. The present experiment thus tests 3- and 4-year olds' generalization of knowledge of object functions to knowledge of object labels. The object function history phase used the exact procedures that were used in Experiment 2 of Birch et al. (2008), and the object label test phase used the exact procedures that were used in Experiment 1 of the same publication[4]. Using exact procedures that have been used with success to assess children's use of prior accuracy *within* each specific type of information ensures that any lack of extension *across* the two types of information (from object functions to object labels) reflects a genuine failure or reluctance to generalize rather than a procedural difficulty or methodological artifact.

Method.

Participants. Fifty-three children participated in the current study: 25 three-year-olds (11 males; *M* = 43 months; range = 35 to 48 months) and 28 four-year-olds (12 males; *M* = 55

[4] Experiment 1 of the current manuscript was conducted at the same time by the same experimenters using the same exact stimuli as the experiments that were published in *Cognition* in 2008.

months; range = 49 to 61 months). Children were recruited from daycare centers and a database of families interested in psychology research.

Materials. **S**timuli included four objects that are familiar to young children (common objects), eight objects that are unfamiliar to young children (novel objects) and two child-like puppets that served as informants. The common objects were a comb, a miniature basketball, a toothbrush and a toy spoon. The novel objects included a fishing lure, a gadget for clipping glasses to a visor, an egg-holder, a matches container, a soap holder, a garlic press, a wire gadget for displaying ornamental plates and a stick model from a chemistry set.

Procedure. Children participated one at a time either in a university laboratory or in their daycare center. The experiment included a *History Phase* and a *Test Phase*.

History Phase. Participants watched as the experimenter asked the puppets for the functions of the common objects (i.e., asking "What's this for?" while holding each object). One puppet correctly named the all four functions and the other incorrectly named the functions (for example, stating that the ball was "for washing your clothes"). The puppets never provided any labels for the objects, only referring to them as "that". The order of presentation of the puppets was kept constant across all children (i.e., the same puppet always spoke first); however, whether the first or the second puppet was accurate was counterbalanced.

Test Phase. Children were tested on two 'Preference' trials and two 'Contrast' trials, the order of which was counterbalanced. On 'Preference' trials, the experimenter presented a pair of novel objects to the puppets and asked, "What's this called?". The first puppet called one object with a novel label (e.g., "ferber"), and the second puppet applied the same novel label to the other object. The side on which each object was placed (and hence the order of their introduction) was counterbalanced. Following this, the experimenter closed her eyes and cupped her hands in a ‘give me’ gesture and asked the child for the referent of the label (i.e., “Can you give me the [ferber] ?”).

The ‘Contrast’ trials were similar, except that the experimenter asked for an object with a *different* label than the one provided by the puppets. For instance, each puppet called a different object a “koba”, but the experimenter asked the child for the “modi,” a label the child had never heard. The Contrast trials were included, as in Birch et al. (2008), to test the robustness of children’s learning by determining if they applied the principle of mutual exclusivity (e.g., Markman & Wachtel, 1988) to the newly-learned labels and to control for the possibility that children might appear to succeed by simply using a heuristic such as “always pick the object that the accurate informant pointed to” rather than truly learning the labels.

At the end, children were asked post-test questions about the correct functions of the common objects to ensure that they were indeed familiar (all children were correct on these questions), and to test whether they explicitly recalled which puppet had accurately provided the functions of the objects. Thirty-three out of 53 children (62%) correctly answered this question. The rate of success on this explicit post-test question was quite low in this experiment. Although some studies on children’s use of past accuracy focused on children who also passed explicit questions, we included all children regardless of their performance on this explicit question because, as mentioned above, failing explicit questions does not imply that children do not possess implicit knowledge. Note that multiple studies have shown that the ability to correctly answer explicit questions about informants is not always correlated with children’s ability to use a source’s attributes to moderate their learning (e.g., Chudek et al., 2012; Robinson et al., 2008; Whitcombe & Robinson, 2000). Nonetheless, we repeated our analyses with only those children who passed the explicit question (N=33) and the patterns of means remained the same: All the effects that were significant with the entire sample were also significant in this sub-sample (and conversely, all effects that were non-significant in the analyses of the entire sample were also non-significant in the sub-sample). The results from the entire sample appear below.

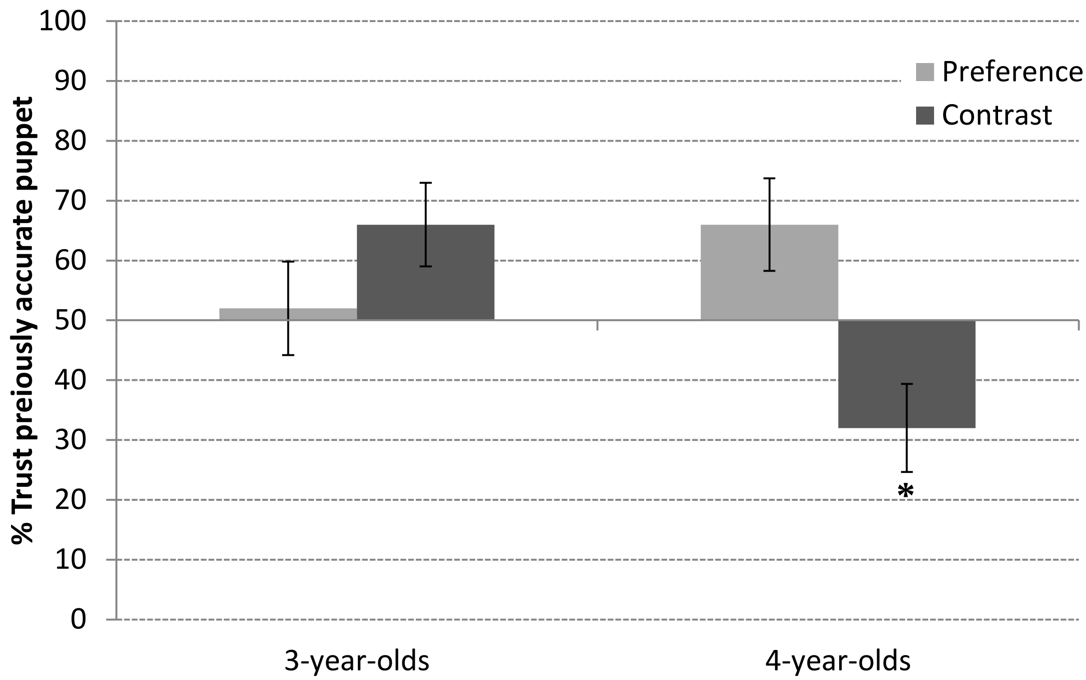
Results and discussion.

Preliminary analyses tested for main effects of speaker order, test order, gender and age, and any interactions between these variables and conditions. No such effects were found except for age, thus other variables were eliminated from subsequent analyses. A 2 (Condition) x 2 (Age) Mixed Analysis of Variance (ANOVA) was conducted with Condition (Preference vs. Contrast) as within-subjects variable and Age (3 years vs. 4 years) as between-subjects variable. The number of times the participant chose the object referred to by the previously accurate speaker served as the dependent measure. This is converted to percentages below for ease of interpretation.

Results are displayed in Figure 1. The omnibus ANOVA did not reveal a significant main effect of Condition, F (1, 51) = 1.75, *ns*, or Age, F (1, 51) = 1.74, *ns*. However there was a significant Condition x Age interaction, F (1, 51) = 10.12, p = .002, η^2=.16. Planned one-sample t-tests revealed that in the 'Preference' Condition, 4-year-olds, but not 3-year-olds, selected the object labeled by the previously accurate individual (M = 66%, t (27) = 2.08, p = .023, one-tailed[5], d=.39; M = 52%, t (24) = 0.25, *ns*, respectively). In the 'Contrast' Condition, 4-year-olds (but not 3-year-olds) showed a significant mutual exclusivity bias, being less likely than chance to choose the object referred to by the accurate speaker when a contrasting label was asked (M =

5 Note that all tests against chance reported in this chapter are one-tailed, because only one direction makes theoretical sense (i.e., only differences showing that children were more likely to learn from the accurate informant than the inaccurate one are interpretable). In the contrast condition, 3-year-olds were actually significantly different from chance with a two-tailed test, but in the wrong direction (i.e., they preferred to associate the contrasting novel label with the object for which the accurate informant had given a *different* label.) If 3-year-olds had shown this pattern while also preferring the object chosen by the accurate informant on Preference trials, we would have considered that 3-year-olds were perhaps generalizing past accuracy but in a very low-level way, simply showing a preference for any object that the accurate informant had interacted with rather than truly learning the novel labels. However, given 3-year-olds' chance performance on the Preference trials, we believe that the results on the Contrast trials reflect random noise in the data.

Figure 1. Results – Experiment 1.



Note: *: p<.05, one-tailed. Error bars show standard errors.

32%, t (27) = 2.42, p = .011, d=.46; M=66%, t (24) = -2.32, n.s., respectively). Thus, across both types of trials, 4-year-olds generalized accuracy from object functions to object labels but 3-year-olds did not show any generalization. Note that 3-year-olds' lack of generalization is especially striking because, with the exception of crossing the History and Test domains, the procedures used were identical to experiments by Birch et al. (2008) in which 3-year-olds successfully preferred to learn from accurate individuals *within the same domain*. It is therefore unlikely that their lack of generalization was due to procedural difficulties.

The present study thus suggests that there is developmental change from age 3 to 4 in children's tendency to generalize an informant's accuracy. From just looking at two types of information, however, one cannot tell whether this finding is representative of children's general patterns of generalization or whether it is specific to the relationship between these two types of information. Experiment 2 will address this question.

Experiment 2

Experiment 1 demonstrated that 4-year-olds use individuals' accuracy at identifying object functions to infer their knowledge of object labels whereas 3-year-olds do not. Experiment 2 sought to further examine whether this developmental pattern of generalization extends to other types of information. To test this, children in this experiment were asked new questions in addition to object labels. Two of these involved learning objective information: one about a bird's feeding habits (i.e., a question about a specific piece of factual knowledge) and one about counting (i.e., a question addressing the individuals' numerical competence). These questions were selected as examples of types of knowledge that preschool-age children understand and that one could reasonably expect to be related to an individual's knowledge of object functions. An additional trial (a question about which of two foods was tastier) was also included. This question entailed both an objective component (i.e., some foods taste good to all humans and others truly taste terrible) and a subjective component (i.e., one may prefer a certain food over another because of individual differences in food preferences). Due to this subjective component, one's answer to the taste question is less likely to relate to one's knowledge in other areas – it is a matter of opinion, not fact (though whether children appreciate this is an open question). We collectively refer to the Label, Bird, and Counting trials as Knowledge Trials and the Taste trial as an Opinion trial. We included only one trial of each of the four types to insure that the experiment was short and not too taxing for young children. Without multiple trials of each type, we were limited in our ability to test for differences between these types of information, but our purpose was to look at children's overall propensity to generalize across a wider variety of information and see if the age difference that emerged in Experiment 1 would hold for other information.

In sum, the aims of this experiment were to examine whether 4-year-olds would generalize inferences from a history of accuracy with object functions to a variety of areas of knowledge, and assess whether 3-year-olds' failure to generalize is specific to the relation between object functions and object labels or indicative of a more general reluctance (or inability) to generalize accuracy across knowledge types.

Method.

Participants. Forty 3-year-olds (21 males; *M* = 42 months; range = 37 to 48 months) and 40 four-year-olds (18 males; *M* = 54 months; range = 49 to 60 months) were recruited in the same way as in Experiment 1.

Materials. Two new child-like puppets served as informants in this study. The same common objects as in Experiment 1 were used in the *History Phase*. Four of the novel objects from Experiment 1 (the garlic press, egg holder, fishing lure, and gadget for clipping glasses) were used for the 'Label' trial. For the 'Bird' trial, three pictures showing a bird, seeds and insects were used. For the 'Counting' trial, two pairs of colourful boxes with objects inside to create a rattling sound were used. For the Opinion or 'Taste' trial, two pairs of pictures of exotic fruits were used.

Procedure. All children were exposed to a *History Phase* identical to that of Experiment 1. This was followed by a *Test Phase* in which four trials ('Label', 'Bird', 'Counting', and 'Taste') were presented with the order alternating between children so that each trial occurred equally often in first, second, third, and fourth position, and occurred as often *before* and *after* each other type of trial. The 'Label' trial was identical to one of the 'Preference' trials of Experiment 1. Two pairs of objects and novel labels were taken from Experiment 1, and approximately half of the children were presented with each of the object pairs and labels. In the 'Bird' trial, participants watched as the puppets each indicated whether a particular type of bird (depicted in a picture) eats insects or seeds - then children indicated which they thought the bird eats. In the 'Counting' trial, each puppet made a guess about which of two colourful boxes with "lots" of rattling pencils inside had the most pencils after briefly looking inside both boxes. Afterward, children were asked which had more pencils without seeing the contents of the box. Two pairs of boxes were used, with approximately half the children being exposed to each pair. In the Opinion ('Taste') trial, the puppets indicated which of a pair of exotic fruits was "more yummy" after viewing pictures of both, then the child made his/her pick. Two pairs of fruit pictures were used for this trial, with approximately half the children presented with each pair.

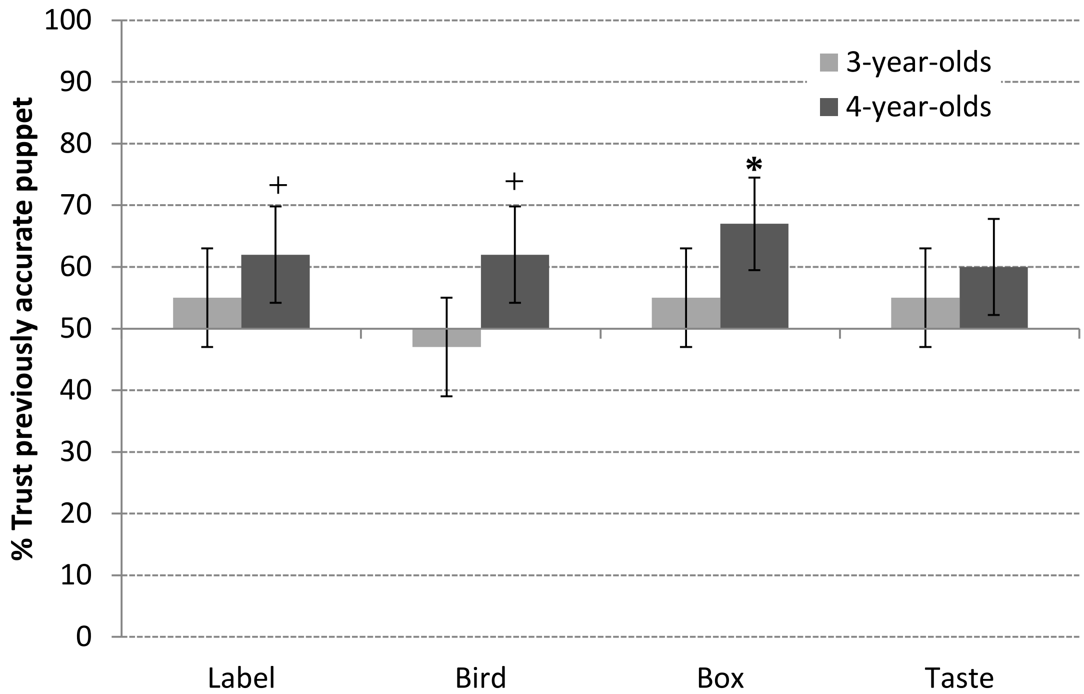
After all four trials, all 4-year-olds and some 3-year-olds were asked a series of questions unrelated to the present experiment. All children except two 3-year-olds were then asked post-test questions. First, they were asked of the name and functions of the four objects shown in the *History Phase*. A few children (eight 3-year-olds and five 4-year-olds) either did not reply or said "I don't know" when asked to describe the function of the ball or mistook the spoon for a shovel; all other children answered these questions correctly. Children were then asked to identify the puppet who had accurately provided the functions of the common objects. The majority of children (66 out of 80: 83%) were correct; one 3-year-old refused to answer the question.

Results and discussion.

The number of times the participant provided the same answer as previously-accurate speaker over the three Knowledge Trials served as the dependent measure. Results are displayed in Figure 2. Preliminary analyses did not reveal any effects of age, gender, speaker order or trial order, or any significant differences between children's performance on the three trials. Even though there was no main effect of age, we had an a priori hypothesis that 4-year-olds would be more likely than chance to provide the same answer as the previously accurate speaker but that 3-year-olds would perform at chance, as in Experiment 1. We therefore compared overall scores against chance (1.5 out of 3 or 50%) with one-tailed one-sample t-tests. Four-year-olds performed significantly above chance (64%, $t(39) = 2.77$, $p = .009$, $d=.44$); in contrast, 3-year-olds were not significantly above chance across all three trials (53%, $t(39) = .51$, *ns*, $d=.08$). As mentioned above, the difference between these two means was in the right direction but not quite significant ($t(78)=1.65$, $p=.104$, two-tailed, *ns*, $d=.37$).

These results appear to demonstrate, once more, that at age 4, but not at age 3, children infer that an informant's knowledge in one area generalizes to other areas of knowledge. Experiments 1 and 2 showed that 3-year-olds follow a "narrow" generalization strategy; yet, it is not entirely clear whether 4-year-olds follow a "broad" (i.e., generalizing to any and all other types of information) or "savvy" strategy (i.e., generalizing only if knowledge evidenced in one area is *informative* about one's knowledge in another area). Evidence for the latter would come from finding at least one domain where less generalization is expected, and showing that indeed

Figure 2. Results – Experiment 2.



Note. +: p<.10, one-tailed; *: p<.05, one-tailed. Error bars show standard errors.

4-year-olds generalize to a lesser extent in such a case. To test this, we chose to contrast children's generalization from knowledge object functions to knowledge of objective and subjective information, the latter being less likely to correlate with knowledge of object functions. In Experiment 2, 4-year-olds' mean value on the Opinion trial was indeed lower than that on other trials, suggesting a sensitivity to this distinction, but there was insufficient power for comparisons across individual trials. Experiment 3 was thus designed to test specifically for such differences.

Experiment 3

Experiment 3 presented 4-year-olds with the same history phase as the previous two experiments, and, at test, three trials in each of two types of information, one for which four-year-old children have shown generalization from object functions (namely, object labels[6]) and one where the "savvy" account should yield less generalization, namely the taste of foods. Though taste has an objective component (e.g., some things truly taste sweet and others do not), food preferences, especially between closely related types of food (e.g., two kinds of breakfast cereal), are very subjective. As mentioned above, preschoolers appear to have some implicit understanding of the subjectivity of food preferences (e.g., Flavell et al., 1990); even toddlers understand that others do not always share their own food preferences (Repacholi & Gopnik, 1997). If 4-year-olds are sensitive to the fact that different individuals' evaluations of the taste of food are subjective and that its correspondence with the child's own preferences is unlikely to be predicted by the individuals' ability to correctly identify object functions, then they should be less likely to side with the previously accurate individual on 'Taste' trials than on 'Label' trials.

[6] We acknowledge that labels are arguably not objective in the rigid sense of the word given that labels are cultural conventions. We use 'objective' here simply to mean matters of fact (that hold across members of a cultural community if not also across cultural communities) as opposed to subjective information or matters of opinion that will vary between members of a cultural community.

Method

Participants. Twenty-four 4-year-olds (13 males; 11 females; *M* = 53 months; range = 48 to 59 months) were recruited through the same means as Experiments 1 and 2.

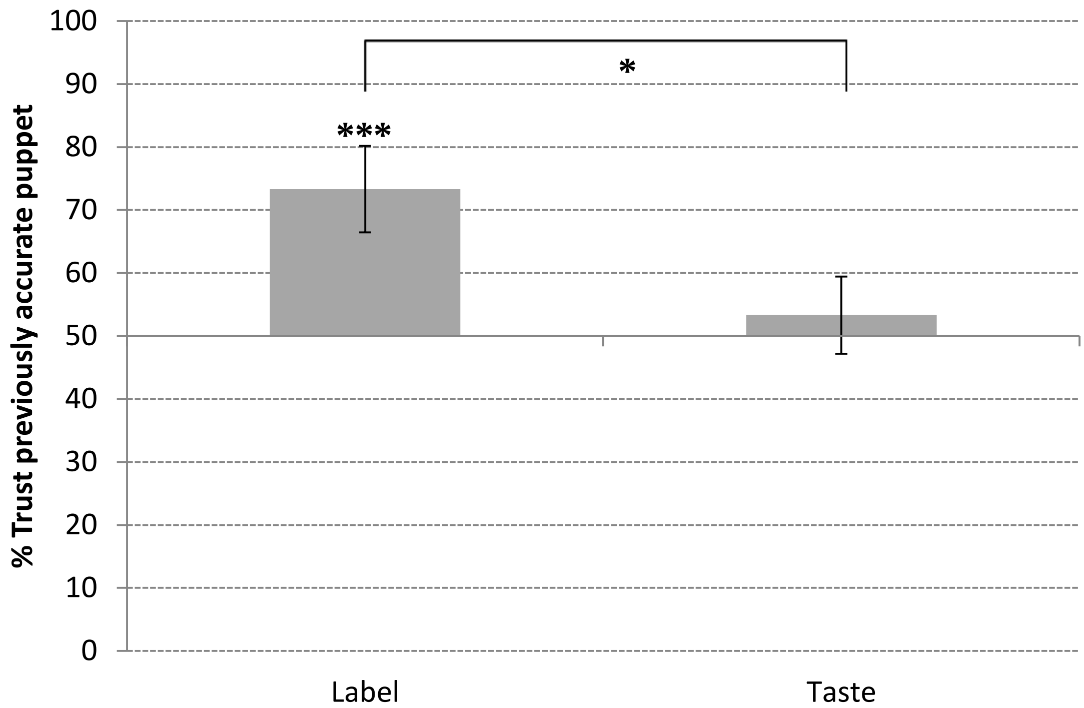
Materials. Two child-like puppets served as informants. The stimuli for the *History Phase* were the same types of objects as in Experiments 1 and 2. The testing phase included six novel objects (a fishing lure, a gadget for clipping glasses, an ornamental plate displayer, a model from a chemistry set, a frame for mounting ornamental plates, and a double-ended measuring cup) and three pairs of pictures showing exotic foods (fruits, cereals, and desserts).

Procedure. The *History Phase* was identical to those of Experiments 1 and 2, with the order of the accurate and inaccurate informants counterbalanced. The *Test Phase* had three 'Label' and three 'Taste' trials, similar to the 'Label' and 'Taste' (Opinion) trials of Experiment 2. 'Label' trials alternated with 'Taste' trials; half the children were presented first with a 'Label' trial and the other half were presented first with a 'Taste' trial. The side of objects on each trial was counterbalanced. After all six trials, children were asked post-test questions similar to those in the previous two experiments. All but five children correctly identified the accurate individual and the functions of all familiar objects.

Results and discussion.

Children's propensity to side with the accurate informant served as dependent variable. Preliminary analyses ruled out any effects of trial order, accurate puppet and object side. Children's overall scores across all three trials in each domain were compared to chance (1.5 out of 3 or 50%) with one-sample t-tests. Results are displayed in Figure 3. Children significantly side with the accurate function-provider on 'Label' trials (76%, $t(23) = 4.06$, $p < .001$, one-tailed,

Figure 3: Results – Experiment 3.



Note. *: p<.05, two-tailed; ***: p<.001, one-tailed. Error bars show standard errors.

d=.83), but not on 'Taste' trials (54%, $t(23) = .33$, one-tailed, *ns*). The difference between the two trial types was significant, ($t(23) = 2.23$, $p = .036$, two-tailed, d=.46).

These results suggest that 4-year-olds' generalization of accuracy follows a "savvy" rather than a "broad" pattern. Four-year-olds did *not* generalize individuals' past accuracy indiscriminately; they used individuals' differences in accuracy at identifying object functions to determine from whom to learn novel labels, but not when learning a more subjective piece of information (the taste of novel foods). It is especially striking that, in a forced-choice situation such as that presented in the current experiment, children would refrain from using the only potential cue they had to decide between the two informants' answers. Hence, 4-year-olds do not generalize individuals' accuracy indiscriminately, but instead make at least one type of principled distinction between types of information—the difference between objective and subjective information.

Note that the present results do not imply that 4-year-olds learn from just anyone in the food domain. Indeed, past studies have demonstrated that children use some cues to differentiate better from worse sources of food-related information (e.g., Brody & Stoneman, 1985; Chudek et al., 2012). Rather, the present results show that 4-year-olds do not moderate their learning about taste based on one specific cue, namely sources' proficiency with a type of information (object functions) that is typically unrelated to taste. Moreover, we specifically highlighted the subjective nature of the food domain here by framing the question as 'which one is tastier?' so it is entirely possible that without this information children *would* follow the food choices of a previously accurate informant in case one food is objectively better (e.g., sweeter, not poisonous) than another. Finally, we wish to make clear that we are not suggesting that there are *never* conditions under which children will generalize knowledge from an objective domain to a subjective domain. We are simply highlighting the fact that four-year-old children are more hesitant to learn at least some types of subjective information than they are to learn some types of objective information from a previously accurate source.

General discussion

The present series of experiments examined 3- and 4-year-olds' use of individuals' past accuracy to moderate their learning across different types of information. Specifically, these experiments tested whether children infer that an informant's knowledge of one area (as evidenced by the informants' prior accuracy in that area) generalizes to other areas of knowledge. Three experiments investigated whether children's use of an informants' accuracy for one type of information corresponds to a 'narrow' pattern, where children only apply an individual's accuracy within the type of information for which that accuracy was demonstrated; a 'broad' pattern, where children use individuals' past accuracy in one domain across all learning situations; or a 'savvy' pattern, where children generalize past accuracy specifically across types of information that they perceive as potentially related.

The present findings demonstrate a developmental change in the breadth of generalization of individuals' accuracy during the preschool period. In the first two experiments, 3-year-olds demonstrated the 'narrow' pattern, or a complete lack of generalization. In Experiment 1, they did not generalize from knowledge of object functions to knowledge of object labels. Experiment 2 demonstrated that 3-year-olds' failure to generalize accuracy is not specific to object labels, but instead holds across other types of information.

There are several possible reasons why 3-year-olds might be unlikely to generalize accuracy. We do not currently favor one explanation over the other; future research aimed at distinguishing these possibilities would be of interest. Of note, these explanations are not mutually exclusive. One likely explanation stems from the fact that with development comes a greater appreciation for the ways in which knowledge clusters. Hence, older children recognize the similarity between different types of information and are willing to accept that knowledge in one area predicts knowledge of the other, whereas 3-year-olds might be treating these areas as disparately as kitchen cabinetry and astrophysics. Lutz and Keil (2002) indeed found that 3-year-olds have a narrower understanding of domain-specific expertise than 4- and 5-year-olds. Three-year-olds understand, for instance, that a car mechanic is more likely to know how to fix a flat tire than a doctor, but, unlike older children, have no intuition about who is more likely to know how to fix a lawn mower.

Three-year-olds' failure to generalize could also be indicative of a more general failure to attribute enduring psychological traits to individuals. As mentioned above, several studies have shown that younger children have more difficulty than older children using behavioural consistencies to make predictions about future behaviour (e.g., Brosseau-Liard & Birch, 2010; Kalish, 2002; Rholes & Ruble, 1984).

Another potential explanation for 3-year-olds' performance has to do with their very robust tendency to trust testimony. Some studies find that young children often trust testimony in spite of direct access to contradicting information (Ganea, Koenig & Millett, 2011; Jaswal, 2010; Jaswal, Croft, Setia & Cole, 2010), suggesting that the bias to trust (rather than distrust) an individual's testimony in early childhood is very robust. To a certain extent, 3-year-olds are able to overcome this bias given that many studies have shown that 3-year-olds (and even younger children) can use past accuracy to moderate their learning. Nonetheless, it remains possible that 3-year-olds are more willing than 4-year-olds to accept information from any speaker *unless* they have very reliable and specific information that, in that *specific* area, the speaker provides inaccurate information.

It is important to mention that at least two past studies (Koenig & Harris, 2005a; Koenig & Jaswal, 2011) have found that 3-year-olds *can* generalize the use of accuracy. As mentioned above, in both of these sources, children generalized accuracy after being prompted to explicitly acknowledge that one of the informants was “not very good at answering questions” or “does not know much about dogs”, and, in Koenig and Harris (2005a), only after performing test trials in the same domain as the accuracy they witnessed (i.e., object labels). Thus, several reasons may explain the difference between these findings and the ones in the current experiments. Perhaps, after 3-year-olds in Koenig and Harris (2005a) made the choice to preferentially learn from the accurate informant on same-domain trials, they persisted in their choice of informant on subsequent trials. Alternatively, or in addition, specific explicit prompts used in Koenig and Harris (2005a) and Koenig and Jaswal (2011) may have helped 3-year-olds demonstrate a more mature pattern of performance. As mentioned earlier, the use of such statements has been found in past studies to influence 4-year-olds’ use of accuracy information when that information was limited in quantity (Fitneva & Dunfield, 2010); it is thus possible that the use of these explicit statements in past studies resulted in 3-year-olds making broader generalizations than they would have made spontaneously.

In contrast to their younger counterparts, 4-year-olds demonstrated a robust pattern of generalization across all three experiments. Most interestingly, their generalization pattern did not follow the indiscriminate “broad” pattern outlined earlier in which one trusts the previously accurate informant for any and all types of information. Instead, they showed “savvy” generalization, using past accuracy across objective information but abstaining from generalizing to at least one type of information that incorporates a subjective element (i.e., taste).

The “savvy” generalization pattern shown by 4-year-olds further demonstrates preschoolers' understanding of the distinction between objective and subjective domains, as shown in previous experiments (e.g., Flavell et al., 1990), and extends this work by showing that they can capitalize on this understanding to guide their social learning. The present research shows thus that by age 4, children can make principled distinctions between different types of knowledge in order to determine whether knowledge (or lack thereof) in one area is likely to predict knowledge (or lack thereof) in another area. However, the fact that 4-year-olds can be "savvy" in their propensity to generalize accuracy across domains does not mean that they are as "savvy" as adults, or that they have reached the end-point of development in this area. The present research demonstrates that 4-year-olds can be savvy, but does not investigate how savvy they are and in what circumstances. For example, it may be of interest for future research to investigate whether children of this age would display a similar understanding in the learning of other types of information with a subjective component, for example evaluations of different individuals' friendliness or preferences between different forms of entertainment (e.g., books, movies, artwork).

It would also be of interest to investigate whether children's generalization of past accuracy is sensitive to more subtle distinctions between objective knowledge domains that adults view as unrelated, for instance between social and physical information or between unrelated academic disciplines (e.g., performing arts and chemistry). Past studies have found that, though preschoolers have some understanding of the ways knowledge clusters in people's minds, this understanding is limited and becomes more complex and adult-like during the elementary school years (e.g., Danovitch & Keil, 2004, 2007; Keil et al., 2008; Keil, Lockhart & Schleger, 2010). One may suspect that these types of more subtle distinctions in generalization of accuracy would not be present in preschoolers but would emerge in school-age children, though this remains to be investigated.

Future research could also investigate whether children's generalization is influenced by whether past accuracy is a good or bad predictor of future accuracy in the domain at hand. Indeed, for some types of information, previous demonstrations of knowledge (in the same domain or in other domains) are predictive of future accuracy, but for some other types of information, previous demonstrations of knowledge can have a remarkably poor predictive value of future knowledge. For instance, general knowledge about object categories (such as their labels or their functions) is probably highly correlated with general knowledge in a variety of other domains; in contrast, knowledge of idiosyncratic information about a specific instance, object, or individual (such as an individual's proper name or the current location of an object) is highly dependent on access to information about that specific instance and hence uncorrelated with one's past demonstrations of general knowledge. The majority of studies of children's use of past accuracy have looked at types of information where past accuracy is a good predictor of future accuracy: Object labels, object functions, norms and rules, for instance. Whether attention to accuracy is also present in other areas is currently an open question. This point will be addressed in subsequent chapters.

One point to keep in mind is that the present studies always presented children with a forced choice between two contradictory pieces of information provided by two different informants. Therefore, although these studies demonstrate that older preschoolers *can* generalize accuracy across certain types of information when forced to trust one informant over another, these results do not indicate whether children would spontaneously apply the same degree of generalization in a non-forced-choice situation. It is possible, for instance, that 4-year-olds would be perfectly happy to learn object labels (or food preferences) from an individual who was previously inaccurate about object functions if that person was the only source of information available to them. It is possible, too, that they would accept the information but "tag" it, in some way, as tentative and be more likely to revise it if subsequently provided with contradictory information from a different source. Evidence that information provided by dubious sources is encoded differently from that provided by trustworthy sources has been found in a few studies (e.g., Koenig & Woodward, 2010; Sabbagh et al., 2003).

In conclusion, the present research demonstrates a developmental change in how preschoolers expect one's knowledge (as evidence through prior accuracy in a given domain) to generalize across domains. Three-year-olds use a "narrow" strategy, refraining from generalizing their use of past accuracy beyond the immediate type of information. Four-year-olds, in contrast, use past accuracy across a variety of areas of knowledge, but do not generalize indiscriminately. At least in one area involving subjectivity, 4-year-olds refrained from using previous accuracy in an objective knowledge area to moderate their learning. The present findings provide an important addition to our understanding of children's selective learning and their ability to reason about how knowledge clusters in people's minds.

Chapter 3. Factors moderating children's generalization of an informant's accuracy: Type of information and presence of an indirect social source.

Introduction

Assessing other people's knowledge is an important skill that facilitates communication and allows one to interpret others' behaviour. It is also a useful skill for social learning, an adaptation that is exceptionally developed in humans. Social learning allows individuals, especially the youngest and least experienced, to acquire a wealth of information in an efficient way without undergoing the trials and costs of individual learning; yet, that is only useful if the information conveyed is accurate. Hence, accurately assessing others' knowledge is desirable because it grants the ability to selectively learn from the most knowledgeable individuals.

For a long time, developmental psychologists believed that assessing others' knowledge was a late-developing skill. Important theorists such as Jean Piaget (1929) emphasized young children's egocentrism, suggesting that preschool-age children were very limited in their perspective-taking abilities (e.g., Piaget & Inhelder, 1969). Findings suggested that young children believe in adults' omniscience (e.g., Mossler, Marvin & Greenberg, 1976; Wimmer et al., 1988), and numerous studies on theory of mind led to the conclusion that young preschoolers believe that others' minds hold a copy of reality rather than a *representation* of reality that can be incomplete or inaccurate (Wellman et al., 2001). The most recent research in this area, however, suggests that earlier procedures underestimated children's knowledge assessment abilities: Using different methodologies, even infants and young preschoolers show that they can accurately assess others' knowledge, albeit not without systematic weaknesses and biases (e.g., O'Neill, 1996; O'Neill et al., 1992; Onishi & Baillargeon, 2005; Pillow, 1989).

Of course, children (and adults) cannot directly observe the knowledge states of others, as this would require telepathic abilities. Fortunately, many observable cues can be used to infer the knowledge of different individuals. Some of these cues directly provide information about an individual's acquisition of a specific piece of knowledge, while others consist of person-specific attributes that tend to correlate with knowledge as an enduring characteristic. Studies have demonstrated that preschoolers can use many cues to knowledge in order to guide their learning, including age (Jaswal & Neely, 2006; Rakoczy et al., 2010), confidence (Birch et al., 2010; Sabbagh & Baldwin, 2001), consensus (Fusaro & Harris, 2008), expertise (Lutz & Keil, 2002; Mills et al., 2010; Sobel & Corriveau, 2010) and visual access to information (Kushnir, Wellman & Gelman, 2008; Pillow, 1989; see Robinson, 2000 for a review).

One knowledge cue that has received a lot of attention from researchers recently is an individual's track record of accuracy. If someone has repeatedly provided accurate information in the past, it is reasonable to assume that they will provide accurate information again in the future; in contrast, if someone has repeatedly been *inaccurate*, any further information they provide should probably be taken with a grain of salt. Multiple studies have demonstrated that preschoolers attend to individuals' past accuracy and use it as a cue when deciding from whom to learn. For instance, Koenig et al. (2004) presented 3- and 4-year-old children with videos of two adults, one who accurately labelled a series of familiar objects and one who labelled them inaccurately. Children subsequently preferred to accept labels for novel objects from the previously accurate informant rather than from the previously inaccurate one. Other studies have since demonstrated sensitivity to past accuracy with various paradigms (e.g., Jaswal & Neely, 2006; Mills et al., 2011; Scofield & Behrend, 2008). Preschoolers track individuals' history of accuracy spontaneously without being explicitly prompted to think about who was right (Birch et al., 2008) and remember a person's accuracy over time delays of at least a week (Corriveau & Harris, 2009b). Even toddlers attend to individuals' past accuracy (Chow et al., 2008; Koenig & Woodward, 2010; Zmyj et al., 2010). However, a greater flexibility in this ability is apparent in children at least 4 years of age. For instance, older preschoolers attend to the relative accuracy of individuals, while younger children have been shown in an experimental setting to refrain from learning from someone who has made even a single mistake (Pasquini et al., 2007).

Thus, ample research demonstrates that children *can* use past accuracy (as well as various other cues) to assess individuals' knowledge. Yet, little attention has been given to the circumstances under which they actually *use* these cues. Previous studies investigating children's use of past accuracy generally created situations where using accuracy was especially easy. For instance, most studies presented a forced-choice manipulation where individuals provided conflicting information about the same objects, hence making the accuracy contrast extremely salient. Forced-choice test trials also allowed effects of accuracy to be revealed whether children were tracking accuracy, inaccuracy, or both. Furthermore, test trials generally provided children with information that was of a very similar type to that shown during the demonstration of accuracy/inaccuracy, hence making the relevance of this earlier phase especially obvious. It is entirely understandable that initial studies investigating whether young children are *at all* capable of tracking prior accuracy would try to make it as easy as possible for them to do so, given that task difficulty can lead researchers to underestimate children's true abilities. Yet, now that we know that preschoolers *can* track and use accuracy, the next step is to assess what factors moderate their propensity to do so.

The present article examines two aspects of this question. First, most studies so far have looked at a contrast between two individuals. However, in many everyday learning situations, children are faced with a single individual from whom they can either learn or not learn. At times, they also have the option to find out information through non-social sources (e.g., by observing and experimenting with the physical world) or 'indirect' social sources (e.g., resources, such as books or the internet, that originated from one or more social sources yet the learner did not witness the author(s) provide this information firsthand and the original source may be unknown or poorly understood by the learner). A couple of studies have examined certain aspects of children's sensitivity to accuracy in a single-speaker setting (e.g., Ganea et al., 2011; Koenig & Woodward, 2010) yet considerable work remains; and no studies have looked at the impact of an individual's accuracy or inaccuracy when children have the option to learn from a source other than an individual who provided firsthand information.

As mentioned above, one of the great advantages of social learning is the ease and availability of social sources, especially in situations where first-person investigation is not possible, impractical, or even dangerous. For instance, it is impossible to determine what a novel object is called simply by examining it; impractical to determine whether it is raining in Vancouver if one is currently in Dubai; and downright dangerous to investigate first-hand whether it is safe to pet a tiger. Interestingly, modern-day children frequently have access to information that comes from people, but indirectly or second-hand (e.g., books, television,the internet). Furthermore, in many circumstances, information is easily available without one having to rely on either a direct or indirect social source. For instance, children do not need to rely on social learning to find out about the colour of the sky: They just need to look up. Nonetheless, sometimes children trust people over their own eyes (e.g., Jaswal, 2010) and the extent of their propensity for social learning remains an open question. Possibly, the general efficacy of social learning makes children inherently motivated to seek out information from people, even when they have other viable options. Still, I hypothesize that any propensity for social learning in the presence of other sources should be moderated by children's sensitivity to the credibility of the social informant. In support of this claim, preschoolers' acceptance of a statement contradicting their own beliefs is sensitive to the source's access to information (e.g., Robinson et al., 1999). The two experiments presented in this chapter test children's propensity for social learning in the presence of an indirect social source and examine whether children's propensity to seek and endorse information directly from an individual is moderated by that individual's previously demonstrated accuracy, even in a situation where it is extremely easy for children to learn from an indirect information source that is described as 'always right'.

In addition, the experiments in this chapter investigate the impact of the similarity between the type of information being learned and that for which the informant demonstrated accuracy (or inaccuracy). The previous chapter, as well as previous studies (e.g., Corriveau et al., 2011; Koenig & Harris, 2005a; Rakoczy et al., 2009), have demonstrated that preschoolers, at least by age 4, readily generalize their use of accuracy across different types of information. Still, there is some evidence that, even at a very young age, children do not generalize accuracy indiscriminately. For instance, children do not use informants' individual differences in accuracy at naming or demonstrating the conventional use of common objects when subsequently choosing which of two novel foods is more tasty (see Chapter 2) or when selecting an object based on preferences (Zmyj et al., 2010). This may be an indication that children are sensitive to the fact that preferences are subjective and that someone who is knowledgeable about more objective types of knowledge does not necessarily share one's food or object preferences.

Apart from these aforementioned studies, there is very little known about the variations in children's generalization of individuals' accuracy across different types of information. This is an important question because knowledge in one area does not predict knowledge in all other areas equally. One important distinction to make is between information that is *generalizable* – category-level information, such as common nouns and conventional functions, that applies not just to one individual object (e.g., *a* dog or *a* car) but to an entire category (e.g., dog*s* or car*s*) – and information that is *idiosyncratic*, or specific to a given individual or instance (e.g., information such as proper nouns, object ownership, or transient physical or psychological properties). This is an important distinction in selective social learning because these two types of knowledge (idiosyncratic and generalizable) are typically uncorrelated and the cues that predict them are very different. Specifically, an individual's level of knowledge of generalizable information is likely to be predicted by person-specific cues (e.g., past accuracy) that indicate how "smart" or "knowledgeable" that person is either in general or on a given topic, while knowledge of a specific piece of idiosyncratic information is likely uncorrelated with general knowledge and much better predicted by situation-specific cues such as information access. For example, upon encountering an individual who demonstrates that they are knowledgeable in a variety of domains, it is reasonable to assume that, were they to meet the author's pet rabbit, they would be able to correctly identify it as a "rabbit" and know many of its other attributes (e.g., that person would not need to count the rabbit's body parts to correctly state that it has four legs, two long ears, and so on; one might also expect that person to know at least some information about rabbit dietary habits, health, and reproduction). In contrast, regardless of how smart that individual is, it would not be reasonable to expect them to know the rabbit's name or to know that the rabbit was at that precise moment hiding under the couch, unless they had access to information about *that specific instance* of the category "rabbit" (i.e., hearing the rabbit's owner mention its name, or seeing the rabbit hop to the couch).

The distinction between generalizable and idiosyncratic information may appear fairly abstract; however, given that these different types of knowledge are predicted by different knowledge cues, it is an extremely useful distinction to make to decide on the relevance of a given knowledge cue. Generally speaking, this distinction capitalizes on the key difference between knowledge as a 'state' and knowledge as a 'trait'. The experiments in the present chapter aim to determine whether young children distinguish between these two types of knowledge when choosing a source of information. Specifically, if children make this distinction, they should generalize an individual's past (in)accuracy with generalizable information to other situations involving learning generalizable information, but not to situations involving the learning of idiosyncratic information.

Past research has demonstrated that children at least as young as 2 are, to at least some degree, sensitive to the difference between generalizable and idiosyncratic properties. For example, in Birch and Bloom (2002, Experiment 1), 2- to 4-year-olds were asked to select which of two objects (e.g., two stuffed dogs) was the referent of either a proper name (e.g., *Jessie*) or a common noun (e.g., *dog*) by an experimenter who claimed to be familiar with only one of the objects. Children typically selected the object familiar to the experimenter in response to a request for the referent of a proper name but were at chance when selecting the referent of a common noun. This suggests that young preschoolers understand that familiarity with an individual is necessary to know that individual's name, but not to know the category-level noun that refers to it. In another experiment, Cimpian and Markman (2008, Experiment 2) found that preschoolers interpreted a grammatically ambiguous sentence as kind-relevant when that sentence pertained to naturally generalizable properties (e.g., about a group of elephants: "they can flap their ears to cool off") but interpreted the same grammatical structure as referring to the specific instances pictured when the sentence was about properties that are normally idiosyncratic (e.g., about a group of elephants: "they are tired"). Similarly, 4- and 7-year-olds appropriately extend generalizable properties to other instances of the same kind but are less likely to extend idiosyncratic properties (Gelman, 1988).

The studies in the present chapter investigate whether this sensitivity to the difference between generalizable and idiosyncratic information is also apparent in children's generalization of individuals' accuracy. Most past studies investigating children's attention to individuals' accuracy have used generalizable information (e.g., category-level labels, conventional functions of artifacts), but these past studies have not tested whether children generalize past accuracy demonstrated with generalizable information to idiosyncratic knowledge. The present studies provide this test by investigating whether children understand that an individual's knowledge (or lack thereof) demonstrated with generalizable information is a predictor of that individual's knowledge of other generalizable information (e.g., the individual should possess knowledge about other types of category-level information) but not of idiosyncratic information (i.e., the individual may or may not know about the contents of specific boxes or about which specific objects an individual happens to own).

Overview of the experiments.

Two experiments were conducted to assess whether preschool- and school-age children use an individual's past accuracy to moderate their propensity towards learning from an individual in a situation where there exists a reliable and readily available alternate source of knowledge, and whether children distinguish between generalizable and idiosyncratic information in their generalization of accuracy. Experiment 4 examined children's propensity to request and endorse information from an individual who, in a *history phase*, had previously provided generalizable information that was either accurate or inaccurate. In this experiment, children also had the option to choose an *indirect social source* of information (i.e., a computer)[7] that was described as accurate; furthermore, some children learned information that was of the same type as that demonstrated in the history phase, and others learned information that was of a different type (but was still of a generalizable nature). Experiment 5 then examined children's

[7] The term indirect social source here refers to a source of knowledge that is neither a person nor a person-like surrogate (e.g., puppet or cartoon character) but indirectly transmits information from a human (i.e., a human experimenter originally created the computer clue). Whether or not children are aware that this computer clue, like other indirect social sources of knowledge (e.g., books, television), was originally created by a human is not of importance here; the main distinction being made is between a *direct* social source (i.e., a person or person-like creature) and an alternate type of information source.

propensity for learning from an individual under very similar conditions but for three different types of *idiosyncratic* information.

These experiments focused on older preschoolers (4- and 5-year-olds; hereafter called the "younger" group) and children of early elementary school age (6- and 7-year-olds; hereafter called the "older" group). These age groups were selected because previous studies had shown that children younger than age four are unlikely to generalize accuracy across different areas of knowledge (as demonstrated in Chapter 2) and because there are documented developmental changes in children's understanding of how knowledge clusters in the late preschool and early school-age period (e.g., Danovitch & Keil, 2004, 2007; Lutz & Keil, 2002).

Experiment 4

Experiment 4 aimed to investigate whether children use an individual's past accuracy to moderate their social learning when they also have a reliable non-social cue available to them, and whether this propensity varies based on whether they are learning the same type of information as in the social source's demonstration of accuracy or a different type of information. In the present experiment, children watched a puppet either accurately or inaccurately provide category-level labels and normative functions for a series of common objects. They subsequently had the opportunity to seek and endorse information from that puppet about the category-level labels of novel objects (labels being one of the types of information for which the puppet demonstrated her (in)accuracy) or rules pertaining to the use of objects (a type of information that is generalizable but for which the puppet did not demonstrate (in)accuracy). Importantly, on all test trials, children also had the option to learn from another source of information (a pictorial clue displayed on a computer screen) that was described as accurate, therefore simulating a situation where alternate learning sources are easily available and reliable.

Method.

Participants. Thirty-two children participated in the present experiment: 16 in the Younger group (3,10-5,10; M=4,11; 8 males) and 16 in the Older group (6,0 – 7,4; *M*=6,10; 8 males). Four participants from each age group were randomly and evenly assigned to each of the four cells formed by crossing Information Type (Labels or Rules) and Accuracy (the informant is accurate or inaccurate). Most participants were tested at a local science museum, except three who were tested in a university laboratory.

Material. A single child-like female puppet was used as an informant. Stimuli consisted of pictures of common and uncommon objects arranged in a set sequence on a computer screen. Six small stickers were given to each child as incentives for performance.

Procedure.

History phase. The experimenter first instructed children to sit in front of a computer screen and gave them six small stickers, which children were told they could take home with them later. The experimenter then introduced the puppet, and showed the first four pictures, each depicting a familiar object (a ball, a horse, a spoon, and a car). For pictures 1 and 3 the experimenter asked the puppet "What's this for?" and for pictures 2 and 4 she asked "What's this?" Half the children witnessed the puppet naming all objects and their functions correctly, and the other half of the children witnessed the puppet naming all the objects and functions incorrectly (for example, stating that the ball was "for washing your clothes" and the horse "a cat"). These specific types of information were chosen because they are both generalizable and are similar to types of information that have been used in past accuracy studies (e.g., Birch et al., 2008; Koenig & Harris, 2005a). Two different types of information were presented so as to demonstrate that the puppet's accuracy or lack thereof was not limited to a single area of knowledge.

Instructions for the test. The experimenter then told children that they would be asked questions about objects depicted on the screen. Children were told that for each question they were allowed to either ask the puppet or get a clue from the computer. The experimenter stated that the puppet “may be right or may be wrong”, and that the clue from the computer was “always right”. The computer cue was described in this way in order to give children the option of finding out the true correct answer without having to engage in direct social learning. Children were told that if they got all the answers correct they would keep the stickers that they were given at the beginning of the experiment and win some more stickers, but that if they got any question wrong they would lose all the stickers they were just given. At the end of the experiment, all children were allowed to keep their stickers and select additional ones, regardless of their answers.

Each child then underwent six test trials. For an individual participant, the six test trials were all of the same type: Labels or Rules. Children in the Labels condition were told, before all test trials, that they would see pictures and would have to guess what the objects depicted were called. For each trial, they were then shown a computer image that included pictures of four unusual-looking objects. The experimenter then stated that “one of these is called a (novel label)” and that they had to guess which object corresponded to the novel label. For children in the Rules condition, children were told before all test trials that they would see pictures of objects, some of which were “OK to play with” and some of which were “not OK to play with because there’s a rule that says it’s not OK to play with them”. Then, for each trial, children were shown the same objects as those in the Labels condition and were told that one of the four objects pictured on the computer screen was “OK to play with” and that they had to guess which one.

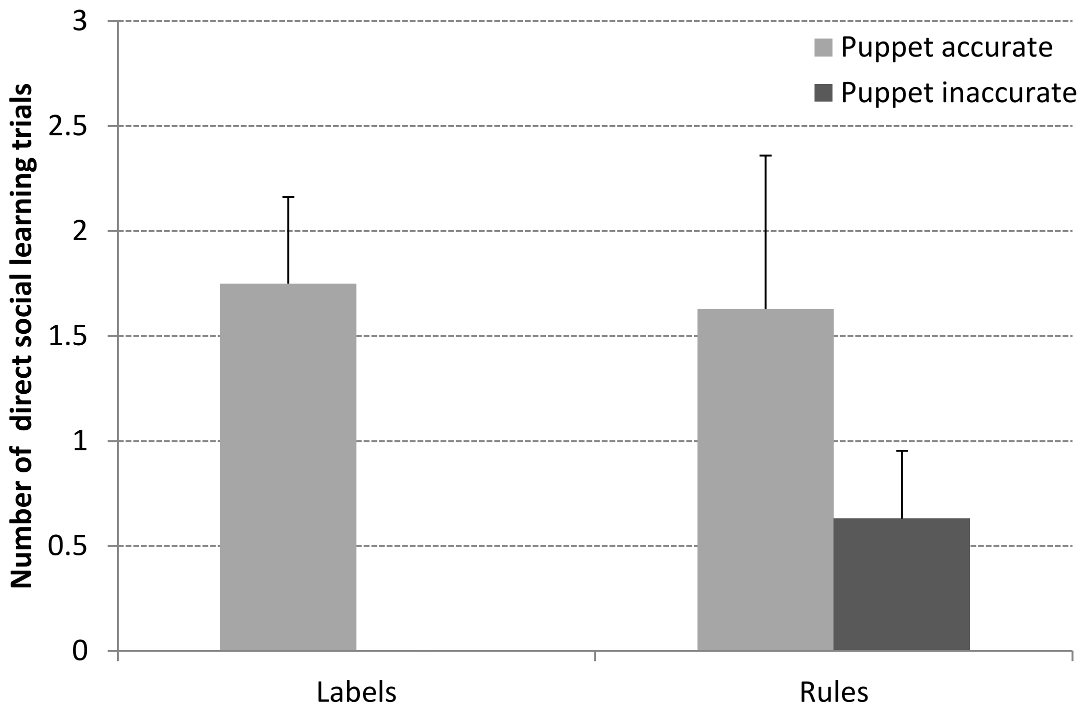
In both the Labels and Rules conditions, children were told that, before providing their guess, they had to select a clue either from the puppet or the computer. If they selected the puppet, the experimenter asked the puppet what she thought and then manipulated the puppet so that she would point towards one of the pictures on the screen. If children selected the computer clue, the experimenter pressed a key and a "happy face" floated towards one of the pictures. Once the selected source provided information, children were asked to provide their own answer. They could thus choose to side with the answer provided by the source they selected (puppet or computer) or choose one of the other three pictures on the screen.

Scoring. Children were scored on how often out of six test trials they engaged in *direct social learning,* which was defined as first selecting the puppet as the clue provider and subsequently choosing the same answer as the puppet. All trials where children selected the computer, or selected the puppet but guessed something other than what the puppet pointed to, were not counted as direct social learning. As children could either choose the puppet or the computer clue and subsequently either endorse the puppet's choice or pick one of the other three pictures, the probability of direct social learning on each trial if children were selecting completely randomly would be 1/8 (2 sources x 4 answer options), for a total chance rate of direct social learning of .75 out of 6 trials.

Results and discussion.

The number of trials where children engaged in direct social learning served as a dependent variable for all analyses. Results are displayed in Figure 4. An Accuracy (2) x Information Type (2) x Age Group (2) between-subjects ANOVA did not reveal any main effects of Information Type, $F(1,24)=.30$, *ns*, or Age Group, $F(1,24)=1.20$, *ns*. There was, however, a significant main effect of Accuracy, $F(1,24)=9.08$, $p=.006$, $\eta^2=.16$. Children asked and learned from the accurate informant an average of 1.69 trials, but asked and learned from the

Figure 4. Results – Experiment 4, age groups combined.



Note: Error bars show standard errors. The number of direct social learning trials in the Labels – Puppet inaccurate condition was equal to zero, hence the absence of a visible bar for this condition.

inaccurate informant an average of .31 trials. There were no significant interactions (all *p*s > .18). The effect of accuracy is observed in the pattern of means for both Labels (Accurate: *M*=1.75 trials; Inaccurate: *M*=.00 trials) and Rules (Accurate: *M*=1.63 trials; Inaccurate: *M*=.63 trials); however, the difference between the accurate and inaccurate conditions was only significant for Labels, $t(7)=4.25$, $p=.004$ (equal variances not assumed), $d=1.06$ – a specific type of knowledge for which the informant had demonstrated her (in)accuracy.

Table 1 shows the average number of trials on which children displayed each possible combination of cue selection and trust (i.e., selecting either the puppet or the computer and subsequently trusting or not trusting the selected cue) by condition. It is worth noting that children's modal response was to select and subsequently learn from the computer – probably unsurprising given that the computer was explicitly described as "always right".

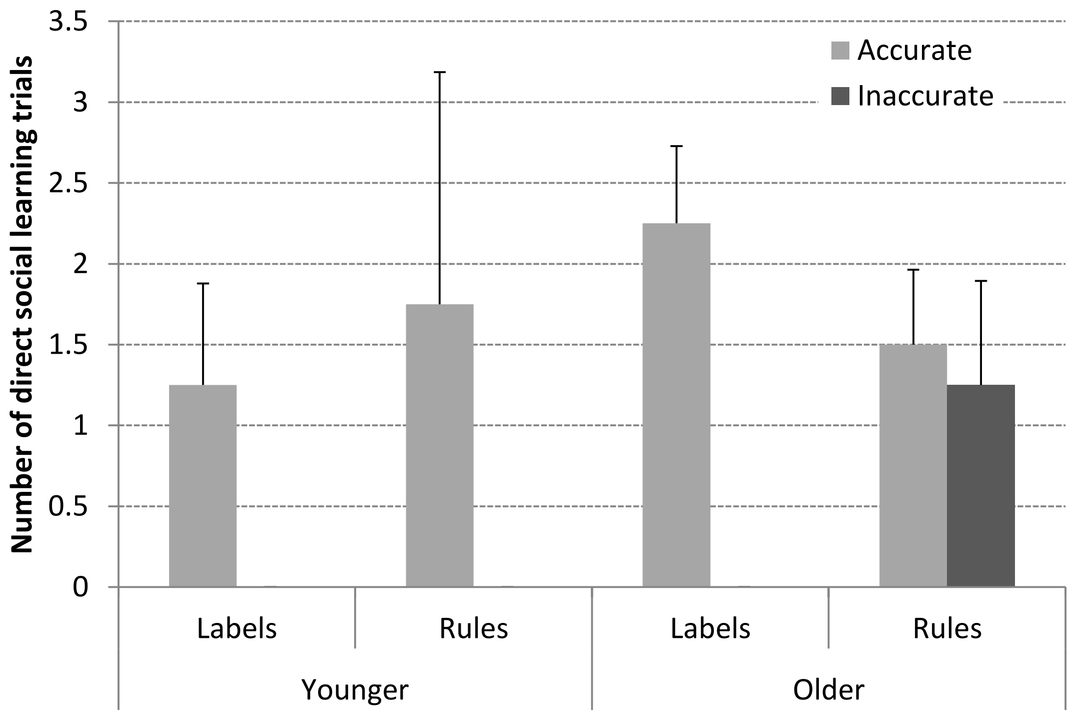
Even though there was no significant main effect or interaction involving age group, two Accuracy (2) x Information Type (2) between-subjects ANOVAs were run separately for the Younger and Older children because of an expectation, based on earlier work (e.g., Gelman, 1988), that the preschool-age children would be less sensitive to subtle differences in information type than the school-age children. Note that, given the non-significant interactions mentioned above and the small sample size (16) within each age group, these separate analyses are meant to be exploratory rather than conclusive.

Figure 5 illustrates the results of Experiment 4 with age groups separated. In the Younger group, the pattern of results closely resembled that of the overall ANOVA: There was a marginally significant effect of Accuracy, $F(1,12)=3.66$, $p=.080$, $\eta^2=.18$, and no other significant or marginal effects. The pattern of means was similar for Labels (Accurate: *M*=1.25; Inaccurate: *M*=.00) and Rules (Accurate: *M*=1.75; Inaccurate: *M*=.00). For the Older group, however, there

Table 1. Mean number of trials (out of 6) each possible answer option was selected in each condition of Experiments 4 and 5.

Condition	Puppet's accuracy	Selected puppet, sided with puppet's answer	Selected puppet, then chose a different answer	Selected computer, sided with object indicated by computer	Selected computer, then chose a different answer
Labels (Experiment 4)	Accurate	1.75	.38	3.75	.12
Labels (Experiment 4)	Inaccurate	.00	.38	4.38	1.25
Rules (Experiment 4)	Accurate	1.63	1.00	2.75	.63
Rules (Experiment 4)	Inaccurate	.63	1.37	3.00	1.00
Location (Experiment 5)	Accurate	.50	.63	3.00	1.88
Location (Experiment 5)	Inaccurate	.50	.88	3.38	1.25
Ownership (Experiment 5)	Accurate	.25	.88	3.50	1.38
Ownership (Experiment 5)	Inaccurate	.63	.50	4.00	.88
Transient property (Experiment 5)	Accurate	.63	1.00	3.25	1.13
Transient property (Experiment 5)	Inaccurate	.25	.88	3.25	1.63

Figure 5. Results – Experiment 4, age groups separated.



Note: Error bars show standard errors. The number of direct social learning trials was equal to zero in the Labels – Inaccurate condition for both age groups and the Rules – Inaccurate condition for the Younger group, hence the absence of visible bars for these conditions.

was both a significant main effect of Accuracy, $F(1,12)=7.14$, $p=.020$, $\eta^2=.14$, and a marginally significant interaction between Accuracy and Information Type, $F(1,12)=4.57$, $p=.054$, $\eta^2=.09$. Looking at the pattern of means, the accuracy effect appears very large for Labels (Accurate: $M=2.25$; Inaccurate: $M=.00$) but nearly non-existent for Rules (Accurate: $M=1.50$; Inaccurate: $M=1.25$). Again, since these results are based on exploratory analyses and very small sample sizes ($N=4$ per cell), it is inappropriate to draw definitive conclusions, especially for effects that are merely marginally significant. Still, this pattern is consistent with the hypothesis that school-age children are more sensitive to small differences between information types than preschoolers and recognize that the informant's track record at labeling is most informative when learning other labels and less informative when learning about other information such as social rules.

Regardless of whether or not this latter difference would hold in a larger sample, the primary results of the present experiment clearly demonstrate that children do use a potential informant's track record of accuracy to decide whether or not to engage in direct social learning, even in a situation where there is an appealing alternative source of information (i.e., one that is described as "always right"). Furthermore, children do not appear to restrict their use of the individual's track record of accuracy to the exact type of information for which the informant demonstrated (in)accuracy: Consistent with previous research (e.g., Koenig & Harris, 2005a; Rakoczy et al., 2009) and with findings of Chapter 2, children generalize their use of accuracy across different types of information. Importantly, however, all types of information presented in Experiment 4 were *generalizable*, consisting of information that typically or potentially apply to an entire category rather than a single instance (note that rules can apply to a single instance as well as a category, e.g., it is possible that only that particular toy is not to be played with because it is a collector's item, however in a situation where there is no clear indication that a rule only applies to a specific instance it might be wisest to encode it as category-level information).

Experiment 5 explores whether children generalize (in)accuracy demonstrated with generalizable knowledge to types of information that are clearly *idiosyncratic*, or specific to a single instance.

Experiment 5

In Experiment 5, children were presented with a situation that was very similar to that of Experiment 4, with the sole difference being in the types of information that children were asked to learn at test. Children were presented with one of three types of idiosyncratic properties: object location (e.g., “one of these is hidden in a box in my home”), ownership of an object (e.g., “one of these belongs to my grandma”), and transient physical properties of an object (e.g., “one of these has a price tag stuck at the back”). These properties are normally specific to an instance and do not generalize to other objects of the same kind (i.e., if object X is located inside a box and belongs to my grandmother, there is no reason to generalize either of these facts to other objects of the same kind as object X). As mentioned above, knowledge of idiosyncratic information is uncorrelated with prior accuracy at providing generalizable information. If children are sensitive to this difference in predictive power, any effect of accuracy should be *smaller* in the present experiment than in Experiment 4. If, on the contrary, children are insensitive to this distinction, there should be a significant effect of accuracy in Experiment 5 as there was in Experiment 4.

Method.

Participants. Forty-eight children participated in the present experiment: 24 in the Younger group (4,0 – 5,7; *M*=4,10; 12 males) and 24 in the Older group (6,1 – 8,2; *M*=7,0; 12 males). Four participants from each age group were randomly assigned to each of the six cells formed by crossing Information Type (Location, Ownership, Transient Property) and Informant Accuracy (Accurate or Inaccurate). Most participants were tested at a local science museum, except seven who were tested in a university laboratory.

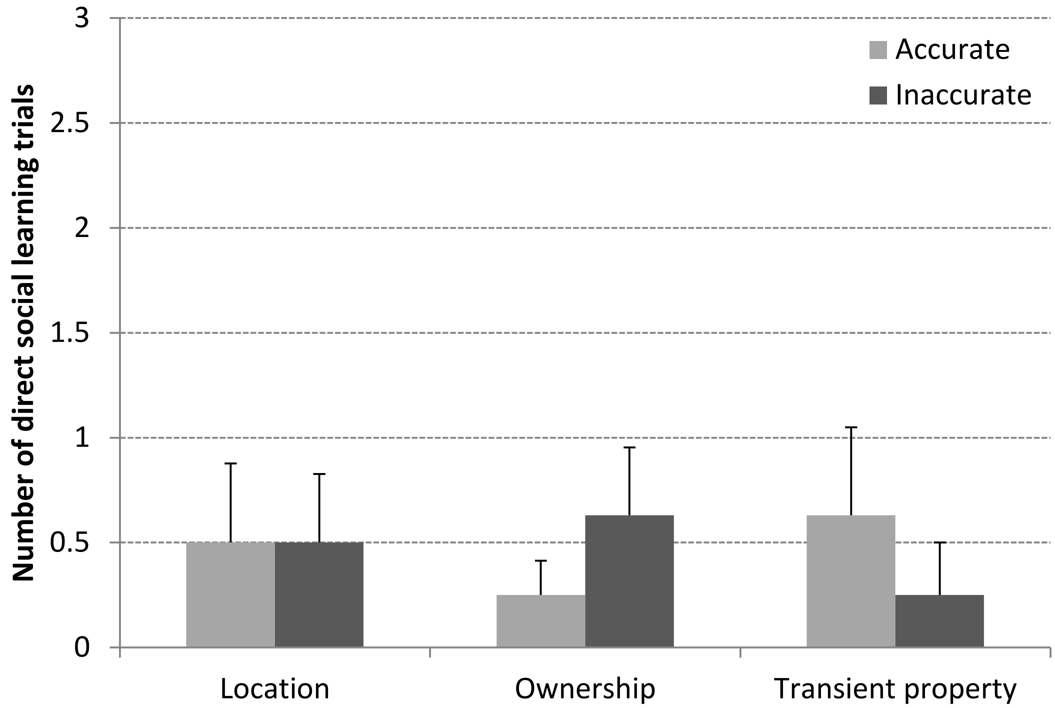
Material. Materials were identical to those of Experiment 4.

Procedure. The procedure was identical to that of Experiment 4, except for the test questions. Children in the Location condition were told before all test trials that they would be shown pictures of several objects, some of which the experimenter keeps inside a box in her house. For each test trial, the experimenter then stated that only one of the four pictures depicted an object that was inside her box. Children in the Ownership condition were told that some pictures represented objects that belonged to the experimenter's grandma; for each test trial, the experimenter stated that one of the four objects depicted belonged to her grandma and children were asked to guess which one it was. For the Transient Property condition, children were told that some of the objects depicted had a price tag at the back and others did not have a price tag. For each test trial, children were told that one of the four objects depicted had a price tag at the back and that they had to guess which one it was. The rest of the procedure and the scoring were identical to Experiment 4.

Results and discussion.

The rate of direct social learning served as the dependent variable in all analyses. Results are displayed in Figure 6. An Accuracy (2) x Information Type (3) x Age (2) ANOVA did not reveal any significant main effects or interactions (all ps >.11). Mean rates of direct social learning were identical (M=.46) for the Accurate and Inaccurate conditions. There was no evidence of an effect of Accuracy for any of the three types of information (Location: Accurate, M=.50, Inaccurate, M=.50; Ownership: Accurate, M=.25, Inaccurate, M=.63; Transient Property: Accurate, M=.63, Inaccurate, M=.25; all ps >.30). Running the analyses separately for Younger and Older children also did not reveal any main effects or interactions. Once again, children's modal response was to select and subsequently learn from the computer (see Table 1).

Figure 6. Results – Experiment 5.

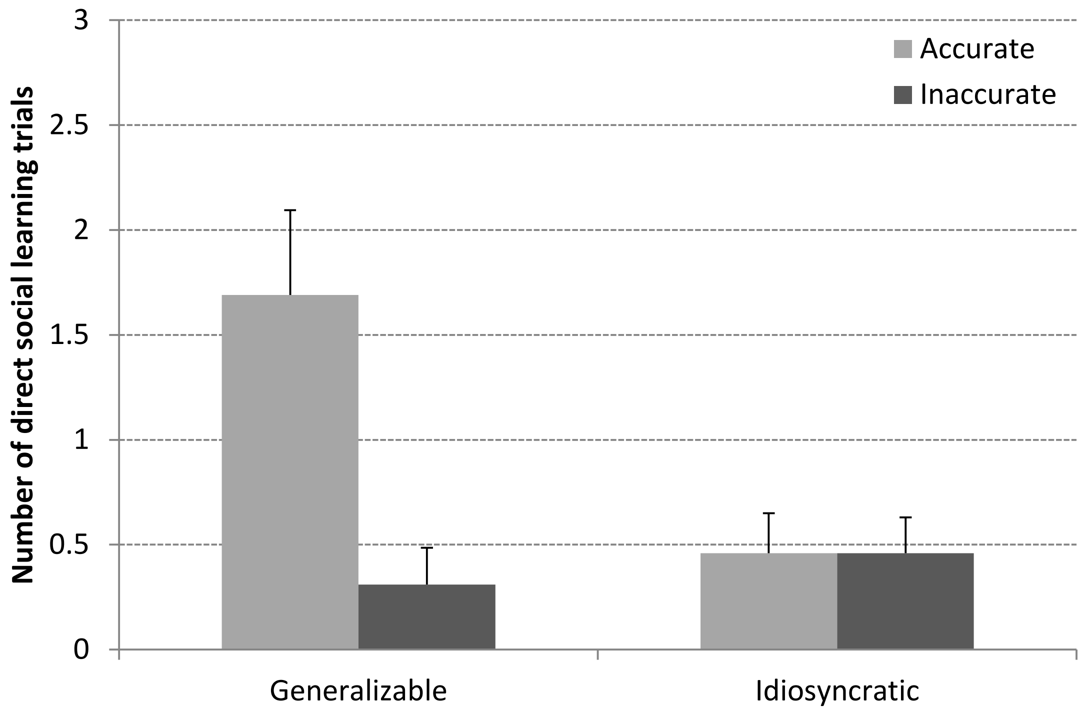


Note: Error bars show standard errors.

Comparing Experiments 4 and 5. In order to conclude that children are indeed sensitive to the difference between generalizable and idiosyncratic information, it does not suffice to show the absence of an effect of Accuracy for the idiosyncratic information; it is also important to show that children use accuracy in a way that is significantly *different* depending on the type of information that they are learning. Hence, an Experiment (2) x Accuracy (2) x Age (2) ANOVA was conducted to determine whether children were more likely to use past accuracy to moderate their learning of generalizable information (Experiment 4) than idiosyncratic information (Experiment 5). Results for this analysis are displayed in Figures 7 and 8. This analysis revealed significant main effects of Experiment, $F(1,72)=5.05$, $p=.028$, $\eta^2=.04$, and Accuracy, $F(1,72)=8.14$, $p=.006$, $\eta^2=.06$; these were moderated by a significant interaction between Experiment and Accuracy, $F(1,72)=8.14$, $p=.006$, $\eta^2=.06$. Thus, the effect of accuracy was indeed significantly greater in Experiment 4 than in Experiment 5. There was no main effect or interaction involving Age Group (all *p*s > .20); running Experiment x Accuracy ANOVAs separately for the Younger and Older groups yields interactions between Experiment and Accuracy that are either significant or marginally significant for both age groups (Younger: $F(1,36)=3.80$, $p=.059$, $\eta^2=.07$; Older: $F(1,36)=4.43$, $p=.042$, $\eta^2=.06$).

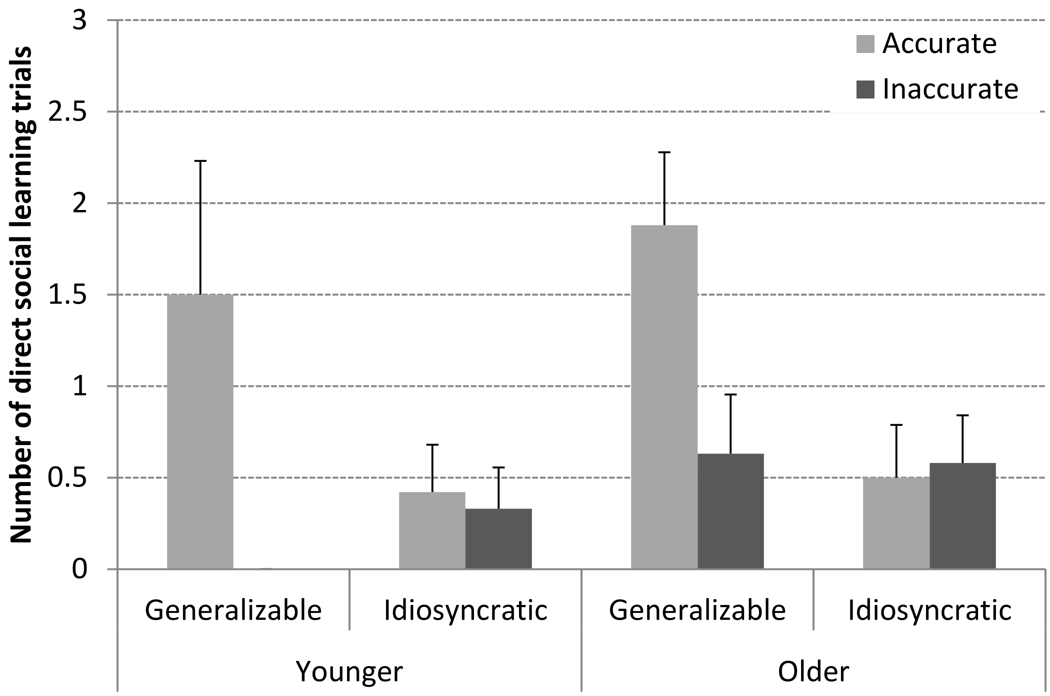
Additionally, there appeared to be a difference between information types in children's propensity to learn from the accurate individual (Generalizable: $M=1.69$; Idiosyncratic: $M=.46$; $t(21.6)=2.75$, $p=.012$, equal variances not assumed, $d=.43$), but when the individual was inaccurate, there was no significant difference in children's propensity to learn from the puppet between information types (Generalizable: $M=.31$; Idiosyncratic: $M=.46$; $t(38)=-.58$, *ns*). It is possible that this is a method artifact: Since chance was at 1/8 per trial or .75 out of 6 trials, the fact that the very low rate of direct social learning from an inaccurate individual did not vary significantly with information type may reflect a floor effect. Comparisons against chance reveal

Figure 7. Results – Comparing Experiments 4 (Generalizable) and 5 (Idiosyncratic), age groups combined.



Note: Error bars show standard errors.

Figure 8. Results – Comparing Experiments 4 (Generalizable) and 5 (Idiosyncratic), age groups separated.



Note: Error bars show standard errors. The number of direct social learning trials was zero in the Generalizable – Inaccurate condition for the Younger group, hence the absence of a visible bar for this condition.

that, when learning generalizable information (Experiment 4), children engaged in direct social learning at a rate that was greater than chance in the Accurate condition, $t(15)=2.31$, $p=.035$, $d=.58$, and below chance in the Inaccurate condition, $t(15)=-2.49$, $p=.025$, $d=.63$, suggesting a sensitivity to *both* accuracy and inaccuracy in spite of the overall low rate of direct social learning. With idiosyncratic information (Experiment 5), however, the rate of direct social learning did not differ from chance in either condition (Accurate: $t(23)=-1.53$, $p=.14$, *ns*; Inaccurate: $t(23)=-1.72$, $p=.10$, *ns*).

In sum, Experiment 4 had demonstrated that children use an individual’s past accuracy when deciding whether or not to learn generalizable information from that individual, whereas in Experiment 5 children did not show any sign of using past accuracy for any of the idiosyncratic types of information. The difference in use of past accuracy between the two types of information was significant. Together, these results suggest that, as hypothesized, children are sensitive to the distinction between generalizable and idiosyncratic information and do not believe that an individual’s past accuracy at providing generalizable information is equally informative of that individual’s knowledge in all subsequent learning situations.

General discussion

Previous research had convincingly demonstrated that young children are sensitive to various cues that provide indications of other individuals' knowledge, and that they can use these cues appropriately to moderate their own learning from these individuals. Yet, little research had investigated how children's use of knowledge cues varies across situations. The present experiments were designed to test whether an individual’s past accuracy is used as a cue to that individual’s usefulness as a source of information despite the availability of an alternative source of information; and whether this knowledge cue is generalized across different types of information.

Experiment 4 first demonstrated that, in a situation where 4- to 7-year-olds had the option to learn new information either from an individual or from a different source that was easily accessible and described as accurate, children's propensity to request and endorse information from the individual was moderated by that individual's demonstrated past accuracy. This effect was present when children were learning words, a type of information that was similar to that presented in the individual's demonstration of (in)accuracy, and also when they were learning another type of information, social rules, for which the individual did not specifically demonstrate accuracy or inaccuracy. Exploratory analyses suggested that older children were somewhat less likely to use past accuracy in the condition requiring generalization of accuracy (Rules) than in the condition where the type of information was similar to that in the history phase (Labels); this might indicate that school-age children are more sensitive than preschoolers to subtle differences between types of information. The age effects, however, were too small to reach significance, thus this finding should be treated as tentative. Very few studies on children's use of past accuracy have tested children beyond the preschool years; it is quite possible that children use this knowledge cue very differently as they get older, especially since their understanding of the ways in which knowledge of different areas clusters in the minds of others changes and becomes more mature during the school-age years (Danovitch & Keil, 2004, 2007; Keil et al., 2008). Future research could test whether children's developing understanding of how knowledge domains cluster translates into an increasingly sophisticated use of individuals' track records of accuracy as a cue to knowledge (i.e., increasing *generalization* across similar types of information combined with increasing *discrimination* between diverging areas of knowledge).

Experiment 4 also provides an important addition to current literature on children's use of knowledge cues by showing that children use knowledge cues not only in situations where they have to choose whether or not to learn from individuals but also when they have to decide between direct social learning and learning from a different type of information source. Many previous studies had shown that children can use past accuracy when deciding between two individuals (e.g., Birch et al., 2008; Koenig et al., 2004) or when deciding whether or not to learn from a single individual (e.g., Ganea et al., 2011). Yet, as mentioned above, children do not only learn directly from people. Often, learning from others is the most practical option for children, but in many situations children can also learn through exploration or observation of non-social information or via indirect social sources such as books. Knowing that children can use knowledge cues in the process of deciding between different types of information sources provides evidence that knowledge cues such as past accuracy likely play an important role in the learning situations that children face every day.

It is worth noting that the rate of learning from the puppet was very low in both Experiments 4 and 5. Given that there were eight possible answers for each trial and that only one of these answers counted as direct social learning, it is to be expected that this type of response would occur infrequently. In fact, as mentioned in Experiment 4, the rate of direct social learning, though low even from the accurate puppet for generalizable information, was actually significantly above what would be expected by chance alone. Still, in most conditions, the modal response was to learn from the computer. This is partly an artifact of the method used: To ensure that children did not entertain any doubt about the reliability of the unfamiliar type of information source, they were told explicitly that this source was always accurate. In fact, it is arguably remarkable that children *ever* chose to learn from the puppet, given that there was uncertainty about its reliability and that the alternate source was explicitly said to be accurate. This may be a result of a natural propensity for young children to seek out and learn information from people. Literature on infants' early propensity for social referencing (e.g., Feinman & Lewis, 1983) and joint attention (Tomasello, 1999) suggests that a tendency to seek out social sources of information is present in the first years of life. Some researchers have additionally posited that young children have a bias to trust testimony (Jaswal et al., 2010) and to learn generalizable information provided in an ostensive teaching context (Csibra & Gergely, 2009).

Although being biased towards people as sources of information may lead to what appear to be suboptimal learning decisions in an artificial experimental situation where a single non-person source is known to be one hundred percent accurate, it may be adaptive in realistic day-to-day learning situations. Indeed, children might benefit from other aspects of this social interaction (e.g., building a relationship with an individual). Furthermore, even if children may acquire information on their own in a given situation or learn from indirect social sources, it is always possible that they would learn more from a live social source. Imagine, for instance, that a young child encounters a dog for the first time. Provided that this child has normal eyesight, he or she can easily learn via first-hand observation that dogs have four legs, two ears and a tail. However, if the dog happens to be a miniature poodle, the child may inaccurately conclude that all dogs are tiny (whereas a child who encounters a German shepherd would reach a very different conclusion). In such a situation, learning "what dogs look like" from an individual who is present rather than relying exclusively on first-hand observation or from a non-interactive medium would be useful because the person likely possesses more information about "what dogs look like" than that which is immediately available to the child's own senses or in a given indirect source of information. In other words, one advantage of relying on people even when other sources of information are available is that people can share additional information pertinent to the present learning situation.

Experiment 4 showed that children generalize their use of accuracy that was demonstrated in two generalizable, category-level areas of knowledge (object functions and labels) to another generalizable type of information (social rules pertaining to the use of objects). Yet, Experiment

5 demonstrated that children do not generalize this accuracy indiscriminately: They appropriately showed no sign of using the individual's demonstrated accuracy (or inaccuracy) in these two generalizable domains when subsequently learning information that is idiosyncratic to a single instance rather than applying to an entire category. This was the case for three different kinds of idiosyncratic information. These results are consistent with past findings showing that 4- to 7-year-olds are sensitive to the distinction between generalizable and idiosyncratic information and additionally demonstrate that children are capable of using this distinction when deciding whether or not to use past accuracy to predict the knowledge of an informant. Specifically, children extend their use of past accuracy across different types of generalizable knowledge, but appropriately refrain from making the same extension from generalizable to idiosyncratic knowledge. Since these two types of knowledge are uncorrelated, avoiding generalizations from one type to the other is warranted.

However, as mentioned above, it is not just past accuracy at *generalizable* information that is a poor predictor of idiosyncratic knowledge: This type of knowledge is also unlikely to be predicted by past accuracy with *any* type of information (including past accuracy with idiosyncratic information). Indeed, idiosyncratic knowledge is highly dependent on situation-specific or instance-specific information access, which necessarily varies with each situation or each instance. Previously demonstrated knowledge with one instance, or in one situation, is thus completely irrelevant for knowledge of a different instance or in a different situation. For example, if person X knows the name of the author's pet rabbit, one cannot infer that person X also knows the name of a different rabbit – one does not in any way imply the other.

There are therefore two different reasons why one would not want to use past accuracy to evaluate the source's knowledge in Experiment 5. As mentioned above, the accuracy was demonstrated with generalizable knowledge, which is not correlated with idiosyncratic knowledge, and thus a poor predictor of knowledge at test. Alternatively, one may realize that an individual's past accuracy in any area of knowledge is a poor predictor of their knowledge of idiosyncratic information, and therefore disregard this cue. Furthermore, these two explanations are not mutually exclusive, thus one may wish to disregard the past accuracy for both reasons at once. Presently, it is impossible to tell which of these explain children's reluctance to use past accuracy in Experiment 5. The next chapter will further investigate this question. However, the mere fact that children did use past accuracy in Experiment 4 but not in Experiment 5 shows that, at the very least, children distinguish between generalizable and idiosyncratic information and understand that past accuracy at generalizable information is a better predictor of subsequent generalizable knowledge than of subsequent idiosyncratic knowledge.

The results obtained here can also help explain a puzzling finding from two series of studies by Nurmsoo and Robinson (2009a, 2009b). In one series of studies (Nurmsoo & Robinson, 2009b), 3- to 7-year-old children were given the opportunity to learn novel objects' labels from one of two informants. In line with previous research, they preferred to learn labels from a previously accurate over a previously inaccurate informant; but they also did so when the previously inaccurate informant was only inaccurate because she had been blindfolded in the familiarization trials. Thus, children overemphasized the importance of past accuracy when learning object labels and failed to appropriately excuse inaccuracy that was due to a temporary restriction on information access. Yet, in a second series of studies (Nurmsoo & Robinson, 2009a), 3- to 5-year-old children behaved in exactly the opposite way. They were asked to guess the identity of a hidden toy with the help of a puppet who had inaccurately identified toys in the past, but in one condition this inaccuracy occurred while the puppet lacked appropriate information access (for example, being asked to identify the toy's colour after having only touched it). Children were more likely to forgive the puppet's past inaccuracy and side with his answer when his inaccuracy was due to inappropriate information access than if he was inaccurate when fully informed.

Nurmsoo and Robinson (2009a, 2009b) suggested different explanations for the apparent discrepancy between their findings. One of these explanations had to do with the type of information that children were learning. The authors pointed out that the decision of whether to learn or not to learn from a potentially questionable source is a trade-off between the risk of learning false and perhaps maladaptive information and the benefits of quick and free acquisition of knowledge that might turn out to be accurate. They suggested that children might be especially cautious and unwilling to trust a dubious source when acquiring information such as words or object functions, because this information can be used broadly for future inferences and thus learning false information has far-reaching consequences. In contrast, for the identification of the current contents of a specific box, learning inaccurate information is not as costly since it does not generalize beyond the specific instance at hand. Though this is a possible explanation, an alternative explanation (congruent with the findings from Experiments 4 and 5 of the present document) is that a *decreased* use of past accuracy when learning about the contents of a box is advantageous for the simple reason that this cue is a poor predictor of idiosyncratic knowledge. Weighing an individual's enduring attributes too highly when learning this type of information could have a detrimental effect by preventing children from using perhaps more appropriate knowledge cues (e.g., perceptual access). In contrast, past accuracy is important when learning object labels because this type of information is generalizable, thus it may be generally advantageous for children to put greater weight on past accuracy in such a learning situation (even if in some situations their emphasis on past accuracy is *too* great).

The present experiments are among the first to investigate the effect of a specific factor (here, past accuracy) that is predicted to influence children’s use of a knowledge cue. Though past research (e.g., Nurmsoo & Robinson, 2009a, 2009b) had shown that past accuracy is not used equally in all learning situations, past studies provided little information about *what* exactly determines whether or not children use past accuracy as a cue. A few researchers had offered speculations about factors that may affect children's use of different knowledge cues (e.g., Perner, 1988; Jaswal, 2010; Rakoczy et al., 2010), but these propositions had rarely been tested explicitly. The experiments presented in this chapter provide such an explicit test.

The present results suggest that the type of information being learned (more specifically, whether this information is generalizable or idiosyncratic) affects 4- to 7-year-olds' use of past accuracy. How children come to make this distinction remains to be investigated. It is possible that the correlation between certain cues and knowledge of different types of information is learned from experience (for instance, children have probably witnessed their parents and teachers, who are normally trustworthy providers of information about the world, display ignorance or false beliefs about idiosyncratic information); thus, children may be able to make this distinction without needing to understand *why* past accuracy is a bad predictor of idiosyncratic knowledge or being able to articulate this distinction at an explicit level. However, the present results in combination with past findings suggest that at the very least children understand that different knowledge cues predict different types of knowledge. Indeed, past research clearly showed that children discriminate between knowledgeable and ignorant social sources of idiosyncratic information when the sources differ on *information access* rather than past accuracy (e.g., Pillow, 1989; Pratt & Bryant, 1990; Robinson et al., 1999). Information access is a causal indicator of knowledge (i.e., having access to information directly causes one to acquire knowledge) and thus relevant regardless of the type of information being learned. A few studies have shown that, when learning about idiosyncratic information such as the current contents of a box or a physical property of an object, children appropriately disregard person-specific knowledge cues such as age but still take into account information access (e.g. Pillow & Weed, 1997).Yet, it remains to be investigated whether children weigh cues pertaining to knowledge *states* (i.e., information access) and cues pertaining to knowledge as a *trait* (e.g., past accuracy) differently based on the predictive value of these cues for the type of information they are learning. If children did so, it would suggest that they possess a rather sophisticated understanding of knowledge cues. The next chapter will explore this question further.

In conclusion, the present experiments demonstrate that children are selective in their use of knowledge cues depending on the nature of the information being learned: An individual's past accuracy at providing generalizable information affects children's willingness to seek and endorse other generalizable (but not idiosyncratic) information from that individual, even in a situation in which children have the option to trust a different source of information that is easily accessible and described as accurate. This research furthers our understanding of children's critical evaluation of knowledge sources, potentially allowing researchers and educators to predict when children are likely to be especially savvy consumers of information and under which circumstances they are in danger of being misled. This understanding thus has potentially important implications for areas of practice, such as education or eyewitness testimony. Moreover, knowing when children use certain knowledge cues provides clues about why they use them and what exactly they understand about different cues' predictive relationship with knowledge. If children were using all knowledge cues equally regardless of their predictive value, one would think that their understanding of these cues was somewhat shallow and possibly that they were using simple associative heuristics. On the contrary, children's ability to flexibly evaluate whether or not a knowledge cue is relevant and informative for a specific situation shows that they possess a deeper understanding of a cue's relationship with knowledge.

Chapter 4. Epistemic states and traits: What preschoolers know about different knowledge cues

Introduction

Making inferences about what others know is a critical facet of human interaction. These inferences enable us to anticipate, understand, and influence the actions of others; they affect our impressions of others; allow us to communicate efficiently with others; and guide our judgments of what and when to learn from others. Investigating children's knowledge assessment abilities is therefore essential for furthering our understanding of both their cognitive and social development.

Investigations of children's mental state understanding have historically focused on *situational cues* to knowledge, such as whether someone had visual access to information or was present or absent during an event (e.g., Buttelmann et al., 2009; Chandler et al., 1989; Onishi & Baillargeon, 2005; O'Neill, 1996; Pillow, 1989; Piaget & Inhelder, 1969; Pratt & Bryant, 1990; Taylor, 1996; Wimmer & Perner, 1983; see Robinson, 2000, and Wellman et al., 2001 for reviews). These investigations have reported that at least by age 4, and possibly much earlier, children appreciate something about how knowledge, as a mental state, is acquired; however, they tell us little about children's understanding of more trait-like knowledge (i.e., knowledge that generalizes across situations).

Recently, there has been increased attention on preschoolers' understanding of these more trait-like or *person-specific* differences in knowledge (e.g., Harris, 2007; Heyman, 2008; Miller, 2000). Many findings suggest that children are sensitive to differences in others' prior accuracy (e.g., Birch et al., 2008; Clément et al., 2004; Corriveau & Harris, 2009b; Jaswal & Neely, 2006; Koenig & Harris, 2005a; Scofield & Behrend, 2008). For example, when presented with two individuals, one accurate and one inaccurate at labeling familiar objects, preschoolers subsequently prefer to learn new labels from the previously accurate informant (e.g., Koenig et al., 2004).

Despite such evidence indicating that preschoolers understand at least some situational and some person-specific cues to knowledge, it remains unclear how they weigh and evaluate these two types of cues when both are available, and whether they appreciate that the predictive value of these cues depends on the learning context. There are many important distinctions between these two types of knowledge cues. Situational cues hold true across all individuals (e.g., everyone who sees inside a box will acquire knowledge of the box's contents), whereas cues such as prior accuracy vary across individuals (i.e., some people will have better track records of accuracy than others). Another distinction between these types of cues pertains to the nature of their relationship with knowledge: Situational cues are causally related to knowledge (i.e., looking in a box causes one to know its contents), whereas person-specific cues correlate with knowledge (e.g., one's prior accuracy correlates with one's future accuracy) but they are not perfectly correlated, nor are they causally related. Also, situational cues (as the name implies) are only informative about someone's knowledge in a particular situation: The fact that Sally looks inside a box and knows what is inside tells us nothing about how knowledgeable she will be on other occasions, even very similar ones (e.g., knowing the contents of another box). In contrast, person-specific cues, such as prior accuracy at labeling objects, tend to be at least somewhat informative about how knowledgeable someone will be in similar situations (e.g., labeling other objects).

Two sets of studies by Nurmsoo and Robinson (2009a; 2009b) yielded contradictory findings regarding children's weighting of these cues. In one series of studies (2009b), 3- to 7-year-olds learned from previously accurate informants and did not differentiate between inaccurate informants who were visually-informed versus visually-uninformed at the time of their inaccurate statements. In the other series of studies (2009a), 3- to 5-year-olds excused past inaccuracy that resulted from being visually uninformed. The authors proposed that one reason for this difference may be that, in the first series of studies, children were learning object labels, which they have no way of finding out except from other people, and therefore they may be especially vigilant of past accuracy when learning information that can only be gleaned in a social context. In contrast, the second series of studies required children to learn information about properties of hidden objects, something they could find out on their own with appropriate visual access. While the present studies were not specifically designed to address the hypothesis raised by Nurmsoo and Robinson (2009a), their findings nonetheless highlight the need for further research in this area.

As explained in Chapter 3, it is also possible that children are less forgiving of inaccuracy when learning labels because past accuracy is more predictive of knowledge of *generalizable* information (such as category-level labels) than of *idiosyncratic* information (such as which object is currently hidden in a specific location). Greater use of past accuracy for the learning of generalizable information would indeed be appropriate given that an individual's past accuracy (a person-specific knowledge cue) is more likely to accurately predict their knowledge of generalizable information than of idiosyncratic information. In other words, if a person has demonstrated in the past that they are knowledgeable, one may assume that this person will know generalizable information about a variety of things, including labels and functions for objects; one may not, however, safely assume that this person is aware of idiosyncratic properties of every unremarkable object in the world.

Information access, on the contrary, is a situational knowledge cue, and as such is extremely relevant for the learning of idiosyncratic information: Having access to information about an instance is a good predictor of possessing knowledge about that instance. For example, knowing that Jimmy has looked inside a box leads one to assume that Jimmy knows what is inside that specific box. For generalizable information, the role of information access is more subtle: While access to *some* information is necessary for the acquisition knowledge, access to *any* instance of the relevant category, whether in the past or present, can lead to the learning of the relevant generalizable property. To illustrate, in order to know that a golden retriever named Fluffy has fur, Jimmy does not need to have ever seen or felt Fluffy: All he needs is to know that Fluffy is a dog and to have learned the fact that dogs have fur-covered bodies at some point in the past (e.g., by having first-hand experience with other dogs, or by having been told about this physical characteristic of dogs).

The present experiments aim to investigate whether preschool-age children understand that different knowledge cues predict different aspects of knowledge. Specifically, the two experiments presented in this chapter test whether children vary in the weight they grant to past accuracy (a person-specific cue) and information access (a situational cue) depending on whether they are learning information that is idiosyncratic or generalizable. Investigating how children weigh different knowledge cues such as past accuracy and information access when learning different types of information can inform us about whether or not children understand that knowledge cues are differentially informative of different types of knowledge.

Overview of the experiments.

To assess whether preschoolers vary in their weighting of knowledge cues depending on the learning situation, the type of knowledge being acquired was manipulated in otherwise identical situations. The present experiments used a paradigm similar to that used in the aforementioned 'prior accuracy' studies, but with a twist: the novel objects that children learned about were hidden inside boxes. In Experiment 6, two informants (one previously accurate and one previously inaccurate) provided conflicting information about novel objects. The type of information being provided by the informants was manipulated – either the visual identity of the hidden objects (*Pointing Test*) or the labels for the hidden objects (*Labeling Test*). Furthermore, one informant had previously demonstrated accuracy and the other had demonstrated inaccuracy; this difference in accuracy was either demonstrated with labels of common objects (*Labeling History*) or the visual identity of hidden common objects (*Pointing History*). These history phases were designed so that each more closely resembled one of the two test conditions: The *Labeling History* phase was very similar in format to the *Labeling Test* (i.e., both informants provided conflicting labels for objects) and the *Pointing History* phase was very similar in format to the *Pointing Test* (i.e., both informants pointed to pictures of objects to identify the contents of a box).

In this design, then, the test phase always involved children learning about the identity of objects hidden inside boxes. This type of information is very much idiosyncratic: It applies to a single object in a specific situation. However, in the *Labeling Test* condition, the information that children were learning (novel labels) had the potential to apply to an entire category of objects: Once they had learned, for instance, that one specific object was labeled a *mirp*, this knowledge could serve them if they encountered other similar objects. The *Labeling Test* condition therefore involved the learning of *both* idiosyncratic information (what is inside a specific box at a specific moment) and generalizable information (what is the category-level label for this type of object). In contrast, the information learned in the *Pointing Test* condition was strictly idiosyncratic: Knowing that a specific strange-looking object is currently hidden in a specific box does not provide any information about any other situation or any other instance of the same object category.

In Experiment 7, children were presented with the same types of history and test phases, but with the addition of another knowledge cue, namely information access. This cue is situational and a useful predictor of idiosyncratic knowledge, therefore it is relevant in both test conditions. On half the trials, the previously accurate puppet looked inside the box (therefore gaining knowledge about its contents). On the other trials, the previously inaccurate puppet was the one looking inside the box. How children integrate the cues of information access and past accuracy, especially on trials where these cues are in conflict, is likely to vary depending on the type of information they are learning – when they are learning information that is strictly idiosyncratic, information access should be granted greater weight than past accuracy; when they are learning information that comprises of both idiosyncratic and generalizable elements, both knowledge cues should be granted importance. See Table 1 for a summary.

Experiment 6

Method.

Participants. One hundred children were recruited from a database of interested parents and local daycares. There were 25 participants in each of four conditions: Label History / Label Test (4,1 – 5,11; *M* = 4,10; 12 males); Label History / Point Test (3,11 – 5,6; *M* = 4,10; 14 males); Point History / Label Test (4,2 – 6,1; *M* = 4,11; 13 males); and Point History / Point Test (4,4 – 5,5; *M* = 4,10; 11 males).

Material. Two female child-like puppets served as informants. The history phase involved four common objects (ball, horse, spoon, and car), and, in the *Pointing History* conditions, one colourful box and eight pictures (four of these pictures depicted the ball, horse, spoon and car, and the other four were of other familiar objects). Four test trials each involved a

Table 2. Summary of knowledge cues and information types in test conditions of Experiments 6 and 7.

Experiment	Knowledge cue(s) available	Test condition	Type(s) of information being learned	Knowledge cue(s) that should be used
Experiment 6	Past accuracy	*Pointing Test*	Idiosyncratic	None
		Labeling Test	Idiosyncratic and generalizable	Past accuracy
Experiment 7	Past accuracy and information access	*Pointing Test*	Idiosyncratic	Information access
		Labeling Test	Idiosyncratic and generalizable	Information access and past accuracy

different coloured box containing an unfamiliar object. The *Pointing Test* condition involved four pairs of pictures of unfamiliar objects.

Procedure. In the History Phase, four common objects were placed in front of the participants. In the *Labeling History* conditions, each puppet labelled all four objects, one correctly and the other incorrectly (e.g., calling the ball “a book”). In the *Pointing History* conditions, the experimenter first put one familiar object inside the coloured box, in view of the puppets. Two pictures were then placed in front of the puppets, and the experimenter asked them to point to the picture that represented the object inside the box. One puppet pointed to the correct picture and the other puppet pointed to the wrong picture. This was repeated for all four familiar objects. For both history phase conditions, the puppets always interacted with the objects in the same order, but whether the first puppet was accurate or inaccurate was alternated across participants.

In the Test Phase, participants were shown the 4 boxes and told that each contained “one toy”. The boxes were set aside and brought out one at a time. In the *Labeling Test* conditions, the experimenter brought out one box and said: ‘See this box? There’s one toy inside. Let’s ask [the puppets] what’s inside the box.’ No information was provided about either puppet’s visual access to the contents of the boxes. When asked, each puppet provided a different novel label. For instance, on the first trial, one puppet said the box contained a “mirp” while the other said that it contained a “preek”. Participants were asked to repeat each novel word, and then asked what they thought was inside. In the *Pointing Test* conditions, the experimenter brought out two pictures of novel objects with each box and told the child, ‘See this box? There’s one toy inside and it’s one of these two (showing the pictures). Let’s ask [the puppets] what’s inside the box.’ Again, no information was provided about either puppet’s visual access to the contents of the boxes. When asked, each puppet pointed to one of the two pictures, providing contradictory answers on every trial. The experimenter then asked the child: “What do *you* think is inside the box?”

In both test conditions, participants were encouraged to guess if they did not answer immediately. Following the last trial, children were asked if they remembered which object each puppet pointed to (or which label each provided), then asked to label the common objects used in the History Phase (all children did this without difficulty), and finally to recall which puppet had correctly labeled or pointed to pictures of the common objects.

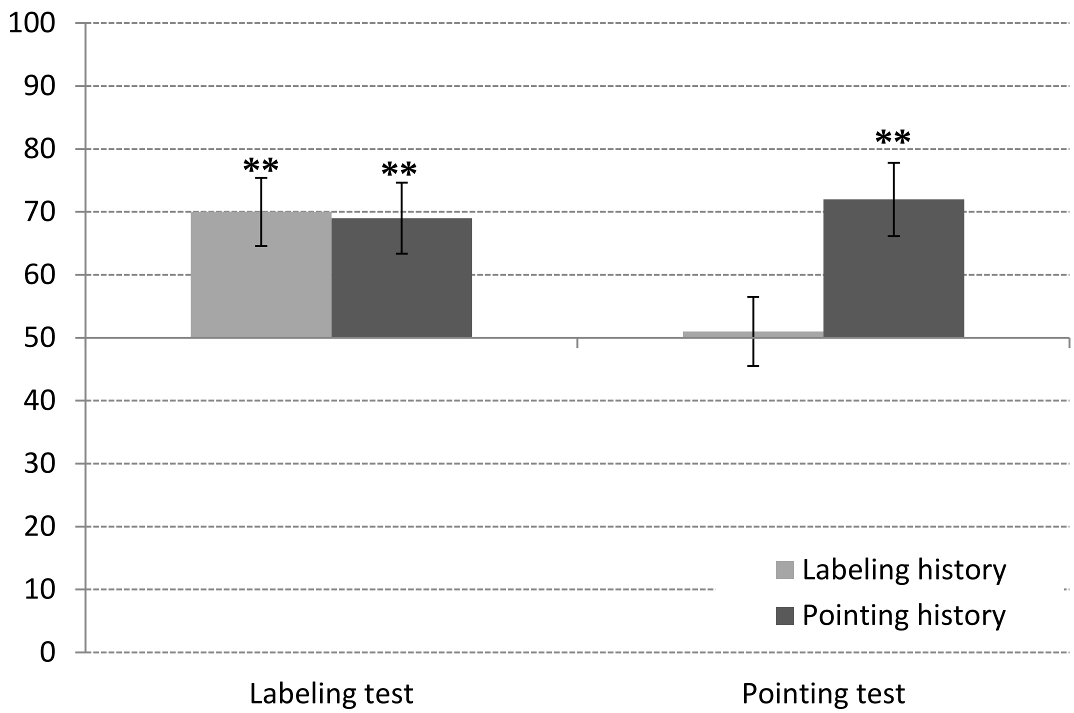
Hypothesized results.

As mentioned earlier, the *Labeling Test* condition involves the learning of both idiosyncratic and generalizable information while the *Pointing Test* only involves the learning of idiosyncratic information. Past accuracy is a better predictor of generalizable knowledge than of idiosyncratic knowledge. If children are sensitive to this, they should prefer to learn from the previously accurate informant in the *Labeling Test* condition, as past accuracy is relevant to the evaluation of generalizable knowledge. It is also possible (although not certain) that, because of the superficial similarity, children in the *Labeling Test* condition would show greater use of the *Labeling History* than of the *Pointing History*. In contrast, children in the *Pointing Test* condition should not use past accuracy, regardless of the type of history phase, because past accuracy is not a useful predictor of idiosyncratic knowledge.

Results.

The number of trials in which children selected the same picture or label as the previously accurate puppet served as the dependent variable, with chance being 2 out of 4 (50%). Results are displayed in Figure 9. A History (Labeling or Pointing) x Test (Labeling or Pointing) between-subjects ANOVA did not reveal any significant main effects or interactions; however,

Figure 9. Results – Experiment 6.



Note: **: p<.01. Error bars show standard errors.

both the main effect of History and the interaction between History and Test were marginally significant (History: $F(1,96) = 3.20$, $p = .077$, $\eta^2=.004$; Test: $F(1,96) = 2.05$, $p = .156$, *ns*; History x Test: $F(1,96) = 3.88$, $p = .052$, $\eta^2=.006$). One-sample t-tests revealed that, for the *Labeling Test*, children preferred to learn from the previously accurate informant regardless of whether that informant was previously accurate about labels ($M = 70\%$; $t(24) = 3.70$, $p = .001$, $d=.74$) or visual identification ($M = 69\%$; $t(24) = 3.37$, $p = .003$, $d=.67$). In contrast, in the *Pointing Test*, children preferred to learn from the previously accurate puppet following the *Pointing History* ($M = 72\%$; $t(24) = 3.77$, $p = .001$, $d=.75$), but not the *Labeling History* ($M = 51\%$; $t(24) = .18$, ns).

Discussion.

The present results partly support the hypothesis that children are more likely to use an individual's past accuracy when the information they learn has a generalizable component. When learning labels, children distinctly used the puppets' past accuracy to moderate their propensity for direct social learning. They did not appear to show greater use of the puppets' (in)accuracy if it had been demonstrated with the same type of information that was now at stake (i.e., labeling objects) than with a different type of information (i.e., visual identification of objects), suggesting that their use of accuracy was not merely driven by the superficial similarity between the history and test phases. In contrast, when learning about the visual properties of hidden objects, children only used past accuracy to moderate their learning if the puppets' demonstration of accuracy was of the same type as the test situation. This finding may suggest that children understand that past accuracy *in general* is a poor predictor of idiosyncratic knowledge; however, they might still consider past (in)accuracy in a situation that is virtually identical to the one they are now facing to be relevant. In other words, mere superficial similarity may play a role in children's consideration of accuracy only in a situation where there is no intrinsically important knowledge cue available to guide their selection of an information source.

Of course, there are alternative interpretations to the present findings. One obvious alternative is that, for some reason, the *Pointing History* phase was just more salient to children than the *Labeling History* phase, or that children believed this type of (in)accuracy to be more likely to generalize across situations. Perhaps children interpreted this history phase as demonstrating, for instance, that the inaccurate puppet was visually impaired (and therefore could not identify any objects). This alternative cannot be ruled out from the findings of Experiment 6 alone; however, Experiment 7 will demonstrate that this explanation is unlikely.

The findings of Experiment 6 could also be interpreted as demonstrating that children are more likely to use *any* knowledge cue for the learning of generalizable information than idiosyncratic information. In other words, they may not understand that past accuracy is more predictive of certain kinds of knowledge than others; they may just be less attentive to whom they learn idiosyncratic information from, possibly because they don't consider this type of information to be very important. This interpretation is rendered somewhat unlikely by the fact that children showed evidence of using one of the history phases in the *Pointing Test* condition – if they truly did not care about individual knowledge when learning idiosyncratic information, it is unlikely that they would use *any* type of history of accuracy. However, another way to address this alternative explanation is by examining children's use of a completely different knowledge cue in the same learning situation. Indeed, past accuracy may not be a useful predictor of idiosyncratic knowledge, but there exist other knowledge cues that are good predictors of this type of knowledge. Specifically, *information access* in a given situation is a powerful predictor of idiosyncratic knowledge in that situation. The use of this knowledge cue will be investigated in Experiment 7.

Experiment 7

In many naturalistic contexts (e.g., outside laboratory experiments) children are faced with multiple knowledge cues and need to navigate through a maze of potential cues by deciding which cues are relevant in a given context, when and how to properly weigh or integrate cues, and how to resolve potentially competing cues. The present experiment specifically investigates how preschoolers handle the presence of both a person-specific and a situational cue in different learning contexts and in situations where these cues conflict.

In Experiment 7, children learned the same types of information as in Experiment 6, however the informants differed in *both* past accuracy and visual access to the contents of the boxes. As in Experiment 6, there were two history types (*Pointing* and *Labeling*) and two test conditions (*Pointing* and *Labeling*). In addition, for two of the four test trials (hereafter labeled *Convergent Trials*), the previously accurate puppet looked inside the test box (thus gaining information access to its contents) while the previously inaccurate puppet stood on the box (thus interacting with the box but not gaining any information about its contents). On the other two trials (hereafter labeled *Divergent Trials*), the previously inaccurate puppet looked inside the box and the previously accurate puppet stood on the box. Hence, children must track and integrate situational and person-specific cues and assess their informative value depending on the type of information being learned.

On convergent trials, both knowledge cues lead to the same conclusion: Trust the puppet who was previously accurate and is currently most informed. On divergent trials, however, past accuracy and information access are in conflict, hence these trials serve to assess the relative weight that children grant to these two cues.

Here, the different explanations for the results of Experiment 6 lead to different predictions. If children believed that the puppet who was inaccurate in the *Pointing History* was visually impaired, then that puppet's visual access to information should be treated as irrelevant, therefore children should either trust the previously accurate puppet or perform at chance on divergent trials following the *Pointing History*. If children instead were unconcerned about individuals' knowledge when learning idiosyncratic information, they should show little use of either visual access or past accuracy (except perhaps for the *Pointing History*, as in Experiment 6) in the *Pointing Test* condition. This should lead to chance performance on both convergent and divergent trials in the *Pointing Test* condition. However, the main hypothesis of this chapter, namely that children are sensitive to the predictive value of past accuracy and information access for generalizable and idiosyncratic knowledge, leads to a predicted pattern of results that is different from those just outlined. The hypothesized pattern of results is explained below and summarized in Table 2.

Hypothesized results.

As explained earlier, past accuracy is a useful predictor of generalizable knowledge (but not idiosyncratic knowledge) and information access is a useful predictor of idiosyncratic knowledge (but is not always necessary for generalizable knowledge). In the present experiment, the *Labeling Test* condition involves the learning of information that comprises both idiosyncratic and generalizable elements, while the *Pointing Test* condition involves the learning of information that is strictly idiosyncratic. Accordingly, the two knowledge cues should be used differently in these two test conditions.

In the *Pointing Test* condition, children are only learning idiosyncratic information; therefore, visual access should trump past accuracy. On convergent trials, the previously

Table 3. Predicted results for Experiment 7.

Test condition	Type(s) of information learned	Trial type	Which knowledge cue(s) are relevant	Which is the visually-informed puppet	Predicted performance
Pointing	Idiosyncratic only	Convergent	Information access only	Accurate	Information access is the only cue that matters. The previously accurate puppet is the one with information access, therefore children should trust the ***accurate*** puppet.
		Divergent	Information access only	Inaccurate	Information access is the only cue that matters. The previously inaccurate puppet is the one with information access, therefore children should trust the ***inaccurate*** puppet.
Labeling	Idiosyncratic and generalizable	Convergent	Information access and past accuracy	Accurate	Both cues matter and converge to indicate the previously accurate puppet as most knowledgeable. Children should therefore trust the ***accurate*** puppet.
		Divergent	Information access and past accuracy	Inaccurate	Both cues matter, yet conflict. With neither puppet being preferable, children should perform ***at chance*** when choosing whom to learn from.

accurate informant is visually informed; children should thus learn from this informant, not because she was previously accurate, but because she has access to relevant information in that specific situation. In contrast, on divergent trials, it is the previously inaccurate puppet that is visually informed, therefore children should trust that puppet on divergent trials (again, because she is the one with information access in that specific situation).

The *Labeling Test* involves learning of *both* idiosyncratic information (what is currently inside a specific box) and generalizable information (what is the object's category-level label). Hence, in this situation, *both cues matter*. Children should have no trouble deciding between informants on convergent trials, as both cues converge to indicate the previously accurate and currently informed puppet as the best choice. However, on divergent trials, both cues are important yet in conflict. With both cues pointing to different answers, children should have difficulty choosing between the two informants and therefore perform at chance.

Note that this last prediction rests on the assumption that children on divergent trials in the *Labeling Test* condition would consider both cues as exactly equally important. If, on the contrary, children view one of these cues as more important than the other, they should be inclined to systematically trust one puppet more than the other. It is possible, for instance, that children would consider information access as more important, since it is a causal indicator of knowledge acquisition (while past accuracy is merely correlated with knowledge). Children might also grant slightly greater weight to past accuracy following the *Labeling History* than following the *Pointing History* (although there was no hint of such a difference in Experiment 6). If they did so, one might expect that divergent trials in the *Labeling Test* condition would reveal greater learning from the previously accurate informant following the *Labeling History* relative to the rate of learning from the previously accurate informant following the *Pointing History*.

Method.

Participants. Sixty-five children were recruited from a database of interested parents and local daycares. There were 16 children in the *Labeling History – Labeling Test* condition (5,0 – 5,10; *M* = 5,5; 9 males); 16 in the *Labeling History – Pointing Test* condition (5,1 – 5,10; *M* = 5,5; 8 males); 16 in the *Pointing History – Labeling Test* condition (5,2 – 5,11; *M* = 5,6; 8 males); and 17 in the *Pointing History – Pointing Test* condition (5,0 – 5,11; *M* = 5,5; 7 males).

Material. Materials were the same as for Experiment 6.

Procedure. The history phases were identical to those of Experiment 6. The test phases were similar to those of Experiment 6, except that visual access was also manipulated such that on each trial, when the box was placed in front of the child, the puppets interacted with the box (one looking inside, the other standing on it). The puppets' interactions with the box ensured that both performed actions on the box but only one was informed about its contents. For some children, the previously accurate puppet looked on trials 1 and 3 and stood on trials 2 and 4, and vice versa for the other children. At the end, children were asked two additional memory questions about who had looked and stood on the last trial.

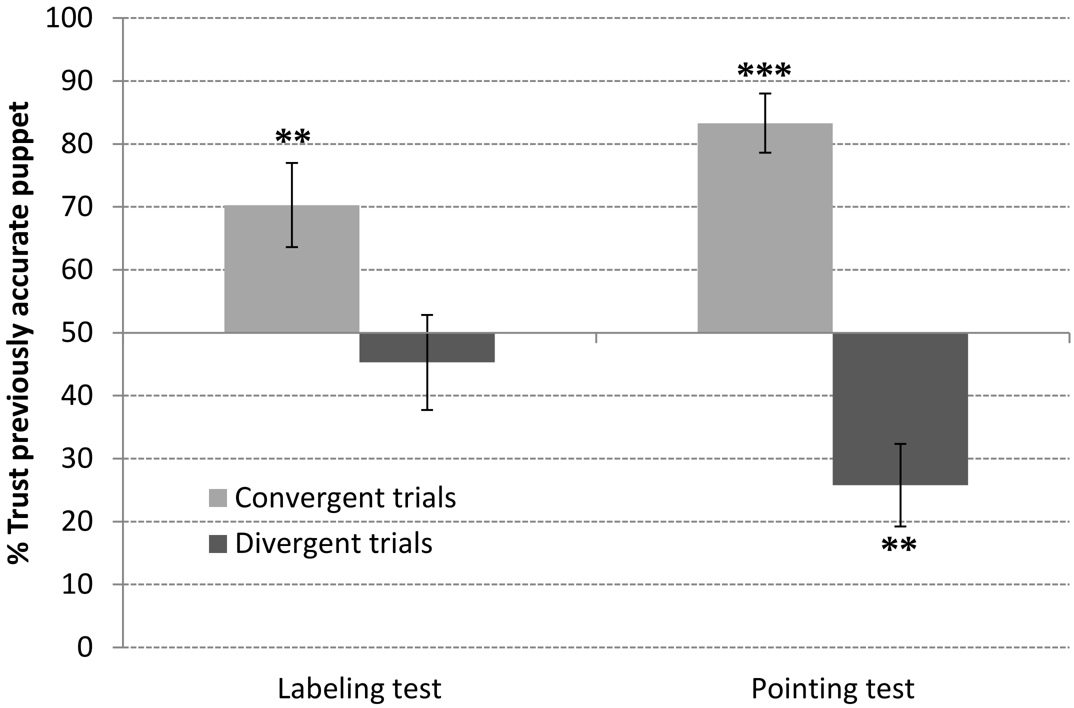
Scoring. Children's performance was calculated separately for the "convergent" trials (i.e., trials where the previously accurate puppet looked inside the box) and "divergent" trials (i.e., trials where the previously inaccurate puppet looked inside the box). On all trials a score of 1 was given for choosing the same picture or label as the previously *accurate* puppet and a score of 0 was given for choosing the same picture or label as the previously *inaccurate* puppet. These scores are converted to percentages below for ease of interpretation.

Results.

Children's performance was analyzed with a mixed ANOVA with Trial Type (Convergent or Divergent) as a within-subjects variable and History (*Labeling* or *Pointing*) and Test (*Labeling* or *Pointing*) as between-subjects variables. There was a significant main effect of Trial Type, $F(1,61) = 36.37$, $p<.001$, $\eta^2=.35$: Overall, children were more likely to side with the previously accurate informant on convergent (M = 76.8%) than divergent (M = 35.5%) trials. This effect was moderated by a significant interaction between Trial Type and Test, $F(1,61) = 5.65$, $p=.021$, $\eta^2=.05$: The difference between convergent and divergent trials was greater for the *Pointing Test* (Convergent: M = 83.3%; Divergent: M = 25.8%) than for the *Labeling Test* (Convergent: M = 70.3%; Divergent: M = 45.3%). One-sample *t*-tests reveal that, in the *Pointing Test* condition, children trusted the previously accurate puppet above chance when she was visually informed, $t(32)=7.09$, $p<.001$, $d=1.24$, and below chance when she was visually uninformed, $t(32)= -3.69$, $p=.001$, $d=.64$, suggesting a robust tendency to trust whoever had visual access to the contents of the box. In contrast, for the *Labeling Test*, children trusted the previously accurate puppet above chance on convergent trials, $t(31)=3.04$, $p=.005$, $d=.54$, but were not different from chance on divergent trials, $t(31)= -.62$, *ns* (see Figure 10).

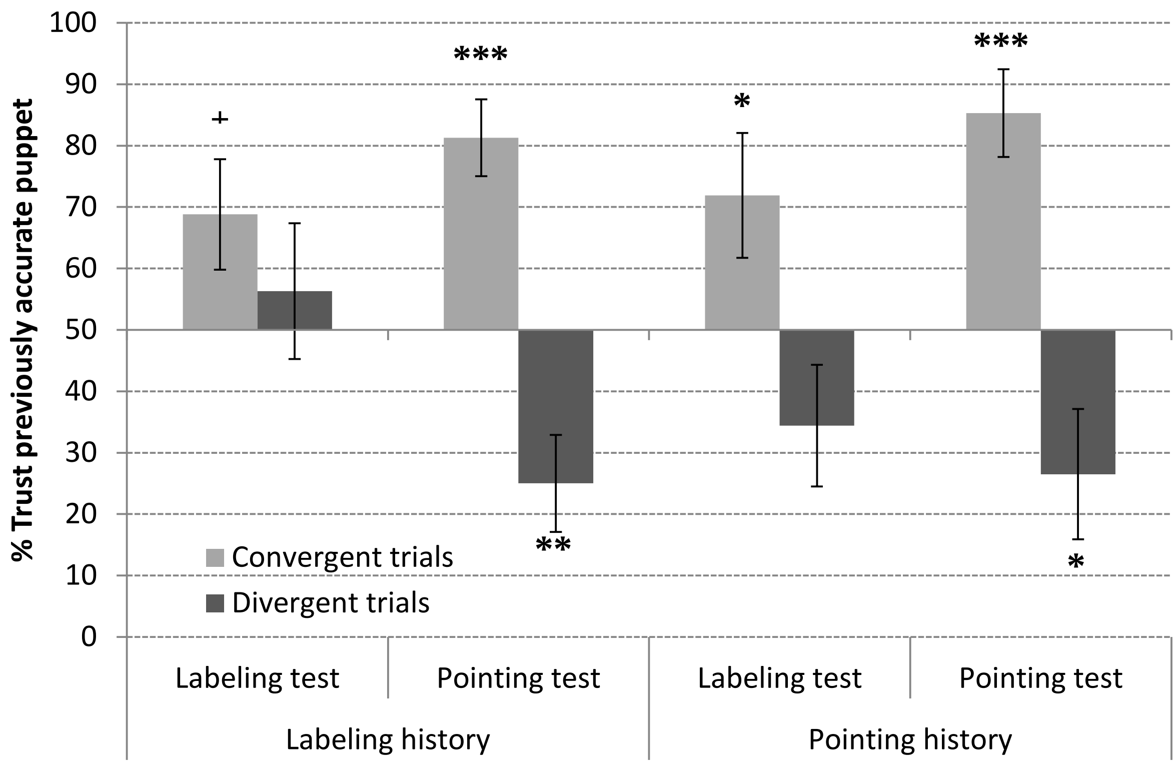
There were no other significant main effects or interactions (all *p*s >.30). Specifically, there was no main effect or interaction involving the type of history phase, suggesting that both types of history phases were treated the same by children. To ensure that effects were indeed the same across both types of history phase, one-sample *t*-tests were repeated separating the history phase conditions (see Figure 11). For both history phases, children in the *Pointing Test* condition trusted the previously accurate puppet on convergent trials (*Labeling History*: M = 81.3%, $t(15)=5.00$, $p<.001$, $d=1.24$; *Pointing History*: M = 85.3%, $t(16)=4.95$, $p<.001$, $d=1.21$) and the previously inaccurate puppet on divergent trials (proportion trusting the accurate puppet,

Figure 10. Results – Experiment 7, pooling across history types.



Note: **: *p*<.01; ***: *p*<.001. Error bars show standard errors.

Figure 11. Results – Experiment 7, separating history types.



Note: +: $p<.10$; *: $p<.05$; **: $p<.01$; ***: $p<.001$. Error bars show standard errors.

Labeling History: *M* = 25.0%, *t*(15)= -3.16, *p*=.006, *d*=.79; *Pointing History*: *M* = 26.5%, *t*(16)= -2.22, *p*=.041, *d*=.54). For those learning labels, children were above chance or marginally above chance on convergent trials (*Labeling History*: *M* = 68.8%, *t*(15)=2.09, *p*=.054, *d*=.52; *Pointing History*: *M* = 71.9%, *t*(15)=2.15, *p*=.048, *d*=.54), and not significantly different from chance on divergent trials (*Labeling History*: *M* = 56.3%, *t*(15)=.57, *p*=.58, *ns*; *Pointing History*: *M* = 34.4%, *t*(15)= -1.58, *p*=.14, *ns*). (Note that, though these last two means appear very different, they are not actually significantly different from each other, *F*(1,61)=2.52, *p*=.12, *ns*. It is possible that the non-significance is due to a lack of power; if this was the case, this would not change the main interpretation of these findings, but rather indicate that, in addition to the effects mentioned above, similarity matters when two important knowledge cues are in conflict. In other words, when in conflict with another cue, children give greater weight to past accuracy demonstrated with the same type of information than with a different type of information. In the *Pointing Test* condition, there was no hint of a similar effect: On divergent trials children equally disregarded both history phases.)

Discussion.

The results of Experiment 7 demonstrate that preschoolers appreciate that visual access and prior accuracy provide different information about who is the most knowledgeable depending on the nature of the information being learned (i.e., an objects' label versus visual identity). Children disregarded prior accuracy when learning idiosyncratic knowledge (i.e., in the *Pointing Test* condition), suggesting that they deemed it irrelevant to the informants' knowledge, but they wisely paid attention to information access. Overall, children in the *Labeling Test* condition did not preferentially attend to either cue on divergent trials. It is important to point out that chance performance on divergent trials is exactly what is expected if children are tracking and equally weighting both cues. One could argue that, since the inaccurate individual repeatedly mislabels things that she can see, the labels that she provides should never be trusted. However, given that past accuracy is only *correlated* with knowledge, while visual access directly *causes* one to acquire knowledge, one may argue that the “best” choice here would be to go with the previously inaccurate but visually-informed individual. Future research could shed light on when children begin to appreciate these more fine-grained or nuanced distinctions in the informativeness of these cues.

The results of Experiment 7 are thus largely consistent with the hypothesis that children possess an understanding of the predictive power of different knowledge cues. They are also largely *inconsistent* with some of the alternative accounts proposed above. If children believed that the inaccurate informant in the *Pointing History* condition (or, for that matter, in the *Labeling History* condition) was visually-impaired, that informant’s visual access to the contents of the boxes should not have had any impact on their willingness to learn from that informant. Alternatively, if children had been unconcerned with informants’ knowledge when learning idiosyncratic information, they would not have shown such an overwhelming tendency to trust the visually-informed puppet. It is difficult to reconcile the current results with any low-level explanation; rather, the most plausible explanation appears to be that children have, at some level, an understanding of the usefulness of different knowledge cues in different situations.

General discussion

The findings presented in this chapter integrate two areas of research that have traditionally been investigated separately but that, when combined, provide a more complete picture of children’s understanding of knowledge in its different forms and what children think about the corresponding antecedents and succedents of these types of knowledge. Previous research had shown that preschoolers appreciate some person-specific and situational cues individually (e.g., Koenig & Harris, 2005a; Pillow, 1989) and appropriately select among cues when some cues are clearly superior knowledge indicators (e.g., Jaswal & Neely, 2006; Pillow & Weed, 1997; VanderBorght & Jaswal, 2009). The present experiments extend this previous research, and demonstrate that children appreciate, at least to some degree, that prior accuracy and visual access provide different information about an informant's knowledge, and that therefore the value of these cues varies across learning situations. The two experiments presented in this chapter showed that preschool-age children appreciate that the type of cue to favour depends on what type of information one is trying to acquire.

This research is an important advancement in our understanding of children's social and epistemic reasoning. In the 'real world', outside contrived laboratory experiments, children will rarely encounter knowledge cues in isolation. More often than not children will need to evaluate multiple cues to people's current level of knowledge. Their decisions to accept or reject others' information will impact their decisions on what information to believe both for idiosyncratic information (e.g., who knows the whereabouts of their lunchbox) and for information that generalizes across contexts (e.g., when learning about properties of the physical world, or when learning social conventions like language and social norms). Importantly, cues differ in their value as predictors of knowledge of these two types of information. Fortunately, the present research demonstrates that preschoolers flexibly (and quite appropriately) used situational and person-specific knowledge cues depending on the type of knowledge they were seeking. Overall, when they were only seeking idiosyncratic information, they did not utilize the informants' past accuracy (unless that accuracy was presented in isolation and was extremely similar to the learning situation) but rather placed emphasis on an individual's visual access. In contrast, when children wanted to learn labels for hidden objects (information comprising both idiosyncratic and generalizable elements), they did use the informants' history of accuracy while still attempting to integrate visual access when this information was available (e.g., Experiment 7, divergent trials).

The present research is the first to demonstrate that preschoolers can utilize situation-specific and person-specific knowledge cues differently depending on the type of information being offered.

The present results also bear on a debate in the literature about the nature of children's interpretations of others' prior accuracy. As mentioned above, studies have shown that children are more likely to learn new information from previously accurate individuals. Yet precisely *how* children interpret others' history of accuracy (or *in*accuracy) is an open question. Researchers have commonly assumed that children prefer to learn from previously accurate individuals because they infer that a previously accurate person is more *knowledgeable*. However, researchers have called for more rigorous testing of alternative explanations (e.g., Birch et al., 2008; Lucas & Lewis, 2010; Nurmsoo & Robinson, 2009a; 2009b). One alternative account, for example, posits that children are simply attending to the individual's 'output' without inferring any underlying psychological states. Under this account, past inaccuracy is treated similarly to unfavourable outcomes for non-social objects. That is, children might ignore a person who continually makes mistakes much like they become uninterested in a broken toy. Other alternative explanations have included the prospect that children view a person's past inaccuracy as indicative of that person being uncooperative, deceptive, silly, or unconventional. Under these alternative accounts children's interpretation may be psychological in nature without involving a knowledge-based attribution. Alternatively, children might imagine that the inaccurate individual is visually impaired (i.e., she mislabeled the objects because she could not *see* them properly). Although the latter may seem unlikely, prior research has shown that children of this age often place *too much* emphasis on the relationship between seeing and knowing (see Robinson, 2000 for a review). Thus, it is conceivable that children think that the inaccurate individual was mistaken because of visual impairment.

Under all of the aforementioned alternative accounts, children are not thought to be interpreting the informants' prior accuracy as person-specific differences in *knowledge*, but in terms of more global characteristics (e.g., being uncooperative) that should apply across contexts. If this were the case, children should disfavour information from a previously inaccurate person regardless of the type of information sought. In contrast, if children are interpreting prior accuracy as indicative of a person's underlying knowledge, they would be wise to also consider situation-specific evidence that bears on that person's knowledge when such evidence is available. For instance, if Jimmy did not witness where Sarah put her sweater, he is unlikely to know where it is regardless of how accurate he has been about other information in the past. Conversely, if Anne did witness where Sarah put her sweater, she is likely to know the its location regardless of how inaccurate she has been about other information in the past.

Previous research was largely consistent with a knowledge-based interpretation of others' prior accuracy, but also with some non-epistemic explanations. Some research had indirectly provided evidence consistent with an epistemic (i.e., knowledge-based) interpretation (e.g., Koenig & Harris, 2005a; Brosseau-Liard & Birch, 2010) or inconsistent with some of the alternative interpretations (e.g., Diesendruck, Carmel & Markson, 2010) while some provided evidence pointing to leaner interpretations (e.g., Nurmsoo & Robinson, 2009b). The current findings show that children do not indiscriminately disfavour information from a previously inaccurate individual, as would be predicted under non-epistemic accounts: they are more likely to use past accuracy in some learning situations than others, and wisely revise their evaluation of the previously inaccurate informant when that informant possesses visual access to information. Consequently, these results suggest that children do not assume that a previously inaccurate person is generally uncooperative, deceptive, unconventional, visually impaired, or a provider of 'bad output'. Instead, the present results favour an epistemic account of children's interpretation of others' accuracy. The present research thus helps clarify the nature of children's interpretations of others' prior accuracy.

In conclusion, the two experiments presented in this chapter build on a large body of research showing that preschool-age children are attentive to person-specific, or trait-like, and situational, or state-like, cues to knowledge, and show that children at this age are also able to evaluate the predictive value of these cues depending on the learning context, rather than using them in a rigid rule-like manner (e.g., 'visual access is always more important than past accuracy'). The present research, therefore, demonstrates a remarkable flexibility in children's assessment of others' knowledge. The different pattern of responding that children show depending on the type of information being sought shows that they appreciate and can capitalize on the differential value of knowledge cues to facilitate the accuracy of their own learning.

Chapter 5. General discussion

Summary of research

The purpose of the research presented in the preceding chapters was to assess variations in children's use of individuals' past accuracy to moderate their social learning as both a means to better understand children's social learning for its practical applications and as a means to gain insight into how children conceptualize the minds of others. Numerous studies conducted during the past decade had demonstrated that children *can* track an individual's past accuracy as a cue to their knowledge and use this information when deciding whom to learn from. These findings added to the important literature on children's use of various indicators and correlates of knowledge. However, few studies before now had investigated variations in children's use of past accuracy. The three sets of experiments presented in this dissertation began to address this key question, focusing primarily on whether children understand that past accuracy has a different predictive value for the knowledge of different types of information. These experiments thus explored children's conception of knowledge and their reasoning about the minds of others. The section below summarizes the findings of this research.

Chapter 2: Generalization of accuracy across types of information.

The first step in determining whether children's use of accuracy varies between different types of information is to assess whether children generalize past accuracy demonstrated in one area of knowledge to other contexts involving the learning of different types of information. Most previous studies investigating children's use of past accuracy had only investigated its use with a single type of information. In fact, the vast majority of studies looked at the use of past accuracy within word learning (see Corriveau & Harris, 2010, for a review); only a handful had investigated the use of past accuracy in other areas, such as the learning of object functions (Birch et al., 2008), rules (Rakoczy et al., 2009), events (Fitneva & Dunfield, 2010) and physical properties of objects (Clément et al., 2004). The few studies that did investigated children's generalization of accuracy across different types of information typically used very similar types of information, such as vocabulary and grammatical rules (e.g., Corriveau et al., 2011), or used prompts that may have induced a tendency to generalize (e.g., Koenig & Harris, 2005a). It was thus an open question whether preschool-age children spontaneously believe that an individual's accuracy in one area is predictive of their knowledge of information in other areas. The three experiments presented in Chapter 2 were designed to assess whether children do spontaneously make this assumption.

The studies in Chapter 2 tested between three different patterns of use of past accuracy: a "narrow" pattern, or no spontaneous generalization of accuracy beyond the immediate type of information; a "broad" pattern, or generalization across all possible learning situations; and a "savvy" pattern, or generalization across more closely related types of knowledge but not across very dissimilar types of knowledge. In the present series of experiments, the more closely related types of knowledge all involved objective information while the more dissimilar information comprised a subjective element. This last pattern, the "savvy" pattern, would demonstrate that preschool-age children can at the very least make *some* principled distinctions between types of information when using another individual's prior accuracy to guide their learning.

In the first two experiments, 3- and 4-year-olds were presented with two individuals who differed in their accuracy at naming the functions of common objects. They were subsequently presented with learning trials where the two individuals provided conflicting information in other areas. In both experiments, 3-year-olds demonstrated a "narrow" pattern of use: They did not show any evidence of generalization beyond knowledge of object functions. In contrast, 4-year-olds did generalize in both these experiments. Experiment 3, designed to test between the "broad" and "savvy" patterns, demonstrated that 4-year-olds generalize accuracy between objective types of information but do not generalize to situations involving the learning of subjective information.

In sum, the three experiments presented in Chapter 2 demonstrated that very young preschoolers do not spontaneously generalize accuracy demonstrated with one type of information to other learning contexts. In contrast, by age 4, children not only generalize individuals' past accuracy across areas of knowledge but also are able to make at least one type of principled distinction to determine whether or not past accuracy is relevant to a learning situation. Subsequent chapters explored this finding in more detail, to examine what other types of principled distinctions preschool- and school-age children can make in their assumptions about how others' knowledge generalizes.

Chapter 3: Generalizing accuracy from generalizable to idiosyncratic information.

The experiments presented in Chapter 2 demonstrated that, by age 4, children do not generalize individuals' past accuracy indiscriminately, but rather are more likely to use individuals' past accuracy to moderate their social learning when they are learning information that is in some way related to that for which the individuals demonstrated accuracy. Indeed, 4-year-olds appeared sensitive to the distinction between objective and subjective information and were more likely to use informants' past accuracy to moderate their learning of objective information than of subjective information. Yet, it is probably not true that being accurate (or inaccurate) when providing one specific type of objective information is equally predictive of future accuracy for *all* other types of objective information. Specifically, if one demonstrates a good (or poor) level of general knowledge with information such as nouns, object functions and other category-level information, this is likely a useful predictor of that individual's knowledge of many other types of category-level, *generalizable* information. It is, however, probably a poor predictor of knowledge of *idiosyncratic* information, or information that applies to a single instance (e.g., information about the current location of a specific object or an object's owner). Idiosyncratic knowledge is usually dependent on accessing information about the specific instance in question and is uncorrelated with general knowledge. Chapter 3 investigated whether children's use of past accuracy is sensitive to this distinction. Past studies had demonstrated that preschool- and young school-age children are, in some contexts at least, sensitive to the difference between these two types of information (e.g., Gelman, 1988). Since knowledge of generalizable and idiosyncratic information are not correlated, it may be wise for children not to generalize an individual's past accuracy between these different types of knowledge.

The experiments in Chapter 3 also investigated whether children use past accuracy in the process of choosing between direct social learning and other means of learning (here, learning information provided by a source of knowledge that is not a person or person-like creature). Past research had shown that children can use past accuracy when choosing between two individuals (e.g., Birch et al., 2008; Koenig et al., 2004; Scofield & Behrend, 2008) or when deciding whether or not to learn from a single individual (e.g., Koenig & Woodward, 2010). However, children do not always learn from people, but also acquire information through other means. Knowing whether or not children spontaneously use an individual's past accuracy when deciding whether to learn from that individual or to engage in a different form of learning is thus likely to provide a better picture of the role that past accuracy likely plays in everyday learning.

In Experiments 4 and 5, children ages 4 to 7 were presented with a single informant who provided either accurate or inaccurate information for two types of generalizable information (object labels and functions). Children subsequently used this information to moderate their rate of direct social learning when they were learning *generalizable* information (Experiment 4), whether that information was of the same type or of a different type from that in the informant's (in)accuracy demonstration. In contrast, children showed no evidence of using this past accuracy when learning three different types of *idiosyncratic* information (Experiment 5).

These results show that older preschoolers and young school-age children can use an individual's history of (in)accuracy when deciding whether to seek and endorse information from that individual in the presence of alternate sources of information; and that they possess some understanding of the distinction between generalizable and idiosyncratic information. Children wisely do not assume that an individual's knowledge of category-level, generalizable information is predictive of knowledge specific to a single instance. This shows that children are sensitive to the difference between generalizable and idiosyncratic information and use this sensitivity when deciding whether or not to generalize an individual's past accuracy to a different type of information.

However, these studies did not specifically test whether children understand that different knowledge cues have a different predictive power for generalizable and idiosyncratic information. Specifically, idiosyncratic knowledge is not well predicted by an individual's past accuracy but is extremely well predicted by an individual's information access. Conversely, for generalizable knowledge, past accuracy is a useful predictor but information access to a specific instance is not always necessary. The subsequent chapter explored this question.

Chapter 4: Use of accuracy for different types of information.

Chapters 2 and 3 demonstrated that, by age 4, children do not generalize an individual's accuracy equally across all types of information. Specifically, children are more likely to generalize accuracy across different types of objective information than from objective information to information that has a subjective component, and to generalize accuracy demonstrated with generalizable information to other types of generalizable information but not to idiosyncratic information. These distinctions are sensible: Accuracy (or lack thereof) with one specific type of information is indicative of knowledge of that type of information, and knowledge in one area is more likely to be correlated with knowledge in areas that share similar characteristics (such as objectivity or generalizability) than in areas that are more dissimilar. However, general knowledge itself (and cues to general knowledge, including past accuracy) is also more predictive of certain types of knowledge than others. Chapter 4 explored children's use of past accuracy, as well as their weighting of past accuracy and information access, for the learning of types of knowledge that are either well or poorly predicted by one's demonstrated general knowledge.

Two types of information were contrasted: Information provided via a hand gesture on the physical appearance of the hidden object, and verbally-provided information about a novel category-level noun for a hidden object. The first type of information was idiosyncratic (i.e., the main information being communicated was which of two objects was currently located inside a specific box). Past accuracy is not a good predictor of knowledge of idiosyncratic information, however information access (i.e., whether or not someone has looked inside the box) is crucial for this type of knowledge. In contrast, the provision of a label for the contents of the box transmits *both* idiosyncratic information (what is the object inside a specific box) and generalizable information (what is the correct category-level noun for this type of object). Since the cue of past accuracy is typically a good predictor of generalizable knowledge and the cue of information access is a good predictor of idiosyncratic knowledge, children in this condition should attend to both of these knowledge cues.

In Experiment 6, children ages 4 and 5 who were given the opportunity to learn novel labels for hidden objects used the past accuracy of informants regardless of whether that accuracy was demonstrated in labeling or in a different way (i.e., via a pointing gesture). In contrast, children who were learning information about the contents of boxes via pointing did not use past accuracy unless one of the two informants had specifically demonstrated that she was incapable of pointing correctly. In Experiment 7, 5-year-olds were presented with informants who differed both in their prior accuracy and in their visual access to the hidden objects. Children learning from the pointing gesture completely disregarded past accuracy and strictly trusted whoever had visual access; those learning novel labels, however, used both past accuracy and visual access to moderate their learning.

These findings demonstrated that, although children are attentive to past accuracy, the weight they put on this accuracy depends on what type of information they are learning and what other knowledge cues are present. Specifically, these findings are consistent with children possessing a tacit understanding that situational cues to knowledge, such as visual access to information, are important to determine whether someone possesses knowledge as a *state* in a specific situation (e.g., knowledge of the current contents of a specific box), but that person-specific knowledge cues, such as past accuracy, are additionally informative of *trait* knowledge – knowledge of generalizable information that applies across situations (e.g., category-level nouns used to refer to a class of objects). Thus, these findings show that preschool-age children have a fairly sophisticated understanding, at least at an implicit level, of what information different cues provide about the knowledge of others.

Broader significance of the research

This research is the first concerted program of research looking at factors that systematically predict variations in children's use of past accuracy. From previous research, it was known that children can use various knowledge cues, including past accuracy. However, the fact that children *can* use a certain knowledge cue does not in any way imply that they *will* use it in all situations where it is available nor that they understand the conditions under which they *should* use it (and those in which they should not). Yet, very little research has investigated what factors moderate children's use of different knowledge cues. The experiments described in the preceding three chapters aimed to fill this gap. Of course, a few studies cannot on their own investigate all factors that moderate children's use of a given knowledge cue; yet, by investigating some of the relevant factors, this research provides a starting point for the broader investigation of variations in children's use of past accuracy and provides a window into children's conceptions of knowledge as both a trait and a mental state.

Knowing what factors moderate children's use of past accuracy has important implications for our understanding of child development. Specifically, the present research provides information on children's mental state understanding; on early source monitoring; on the development of social evaluation and trait attribution; and on children's understanding of the relatedness of various knowledge domains. This research also has the potential to lead to practical applications in several fields. This research's primary contributions to each of these areas are discussed below.

Children's mental state understanding.

First, knowing how children use past accuracy informs us about how they understand and interpret this cue. There has been, in recent literature on children's use of past accuracy, a fair amount of debate pertaining to how exactly children interpret individual differences in accuracy. Initially, many researchers assumed that children saw accurate individuals as possessing knowledge and inaccurate individuals as lacking knowledge (e.g., Koenig & Harris, 2005b), and studies probing children's explicit interpretations yielded findings congruent with this interpretation (e.g., Koenig & Harris, 2005a). However, other researchers have questioned this mentalistic interpretation, and suggested that children's use of past accuracy could be interpreted in much leaner ways (e.g., Lucas & Lewis, 2010; Nurmsoo & Robinson, 2009b). For example, children may track individuals' accuracy just as they would track the proper functioning of a machine without making any attributions of mental states to explain accuracy differences. Under this interpretation, children stop trusting an inaccurate individual for the same reason as they lose interest in a broken toy. It is also possible that children believe that inaccurate individuals are unconventional, or perhaps even "mean" or deceptive.

Under these interpretations, however, the variations in children's use of past accuracy found in the present research would be extremely difficult to explain. Why would they generalize the "poor functioning" of an individual across some types of knowledge but not others? Why would they prefer to trust a previously inaccurate individual with information access to the contents of a box more over a previously accurate but uninformed individual if they believed that the first individual was being mean or trying to trick them? The present findings may not entirely rule out leaner alternative interpretations, but the epistemic interpretation is certainly a better fit with the findings presented in this dissertation than the currently proposed "leaner" interpretations, and these latter interpretations would need to be modified considerably to plausibly account for children's variations in the use of past accuracy.

Note, however, that this flexible use of accuracy was demonstrated with children ages 4 and older; this leaves open the possibility that these lean interpretations are accurate descriptions of younger children's use of accuracy. Children as young as 14 to 18 months have been found to use individuals' track record of accuracy to moderate their learning or their propensity for imitation in several studies (e.g., Chow et al., 2008; Zmyj et al., 2010). Even infants and young preschoolers do not appear to use accuracy in a completely indiscriminate manner, as demonstrated in Chapter 2 and also in past literature (e.g., Zmyj et al., 2010). Yet, it is possible that at these ages children do not (or do not always) make an epistemic interpretation but rather "tag" an individual as having provided poor (or good) information in a specific situation, hence they only use that individual's past accuracy when learning very similar information, and only later learn to interpret this accuracy in terms of knowledge. This is of course a purely speculative explanation, and one must be careful not to draw too broad a conclusion from a few studies using a single paradigm. The literature on children's understanding of false beliefs is an example of how even finding a robust pattern of failure using a certain task and replicating this finding hundreds of times does not rule out that a latent understanding may be present when probed in a different manner (see Saxe, in press, for a review). Nevertheless, it is to be expected that there would be some development in the exact type of knowledge attributions that children make as they gain a better understanding of their social world. Studies that further examine these developmental differences will be fruitful at shedding light on the specific nature of the developmental differences and the mechanisms underlying developmental changes.

Early source monitoring.

The present research also adds to the growing literature showing that children can, at least implicitly, track the sources of their knowledge. As mentioned in Chapter 1, many past studies have shown that preschoolers have difficulty explicitly tracking the source of their knowledge, for instance being incapable of accurately stating whether they have learned something through their own information access or via someone else's testimony (Gopnik & Graf, 1988; Taylor et al., 1994). Yet, others have shown that, though children sometimes fail to explicitly recognize the source of their knowledge, they can still use information about this source to guide their learning (e.g., Robinson & Whitcombe, 2003). This distinction between implicit and explicit source monitoring, it turns out, is also evident in children's generalization of knowledge across types of information. For instance, one past study (Brosseau-Liard & Birch, 2010) found that 4-year-olds who were explicitly asked to attribute knowledge (as well as a variety of other characteristics) to informants who had previously differed in their accuracy at labeling objects showed a very weak tendency to explicitly attribute knowledge of other labels to the more accurate informant and failed to attribute other types of knowledge at all. In contrast, the studies described in the present document clearly demonstrate that 4-year-olds (and older children) do use an individual's past accuracy to make inferences about that person's role as a trustworthy source of knowledge in other areas. Clearly, children are tracking information about the source of their knowledge and using this information at an implicit level to guide their learning in a variety of areas; however, they may not be aware of this process or may not be able to explicitly articulate their expectations about various knowledge sources. This shows that, when assessing processes such as source monitoring that have implications for young children's learning, it is important to keep in mind the distinction between implicit and explicit use of these processes. It is possible that the implicit processes, rather than the corresponding explicit ones, provide the primary influence on children's learning (at least earlier in development); thus, focusing on children's explicit attributions leads to an underestimation of their true abilities.

Social evaluation and trait attribution.

The present work also has important implications for research on children's attributions of traits and dispositions. For instance, Chapter 4 demonstrates that preschool children differentiate between knowledge as a *state* of mind (i.e., being aware of a specific fact in a specific situation) and knowledge as a *trait* (i.e., being 'knowledgeable' more generally). Children appreciate that different types of cues provide information about 'state' and 'trait' knowledge: Perceptual access provides insight into one's state knowledge and prior accuracy provides insight into trait knowledge. Furthermore, they correctly use this distinction to determine whether someone is a useful source of information only in a particular context (e.g., for idiosyncratic information such as knowledge of the contents of a box) or whether that individual is a useful source of information across a broader range of contexts.

In addition, the age-related increase in generalization of accuracy across types of information found in Chapter 2 is consistent with previous literature showing greater attribution of psychological traits as children age (e.g., Liu et al., 2007; Newman, 1991; Rholes & Ruble, 1984; Schuster et al., 1998). This work also shows that older preschoolers, when witnessing an informant's (in)accuracy, make a fairly specific attribution of knowledge or trustworthiness (or lack thereof) for a specific class of information rather than making a global attribution of (in)competence. Yet, some past studies have demonstrated that children do sometimes overgeneralize individuals' attributes in this type of paradigm, for instance explicitly attributing more positive moral attributes and fewer negative moral attributes to an individual who was previously accurate rather than inaccurate (Brosseau-Liard & Birch, 2010). The exact scope of children's attribution of knowledge as a trait following a demonstration of accuracy in one area versus other areas would be interesting avenues of investigation for future research.

Early clustering of areas of knowledge.

Knowing how children use past accuracy also informs us on their understanding of how knowledge clusters in individual's minds. Indeed, in the present studies, children age 4 and older demonstrated a fairly sophisticated understanding of the types of knowledge that people possess and of the predictive value of different knowledge cues. By age 4, they appear to understand that being knowledgeable in one area is likely to predict knowledge in other areas, but that it is not predictive of whether or not one's subjective assessment of food tastiness will converge with their own or whether one is knowledgeable about highly specific information about a single instance. Furthermore, by age 5, children appear to differentiate between the predictive value of past accuracy and information access, and appropriately weigh these two cues depending on the type of information they are learning. Hence, it seems that even preschoolers have a relatively complex understanding of what knowledge consists of and how different cues may predict one's knowledge. Since preschool- and early school-age children's understanding of the relatedness of knowledge domains is still quite rudimentary compared to the distinctions that are made later in life (e.g., Keil et al., 2008), it is impressive to find such a sophisticated use of knowledge cues at such early ages. Future research could use paradigms similar to those used in the studies presented above to better assess children's early clustering of knowledge and how this clustering changes with development.

Implications for areas of practice.

Knowing what factors moderate children's use of past accuracy can of course lead to a better understanding of children's selective learning in their daily lives. Though the experiments presented here are not situations that are typical of children's everyday learning (i.e., these were experimental situations involving puppets with no prior relationship with the child and very simplistic depictions of accuracy and inaccuracy), these types of simplistic experimental situations have the advantage of teasing apart factors that may impact children's selective learning and can set the stage for the investigation of the effect of these same factors in more realistic situations.

Knowing which factors have an impact on children's critical evaluation of sources of information could have important practical implications in several fields. Education is one field that immediately comes to mind. Formal education involves a great deal of learning from various sources, including teachers but also other students, books, videos, and the internet. These sources are also important in more informal educational situations. As mentioned earlier, children do not approach learning situations like passive sponges waiting to absorb any information that comes their way: Rather, they are more credulous in some contexts and more skeptical in others, and educators should benefit from knowledge of children's strengths and weaknesses in this area. It is likely beneficial for educators to know, for instance, that by the time children enter school they already appreciate how certain types of knowledge are predictive of others but that their understanding of precisely which domains of knowledge or areas of expertise tend to be related to others is something that children likely continue to refine throughout their school years.

The research presented here may also help design ways to effectively teach children how to better evaluate source credibility. Indeed, not all sources of information are equal, and one of the goals of many educators in today's very complex world is to teach children how to become better consumers of information and critically evaluate the sources of information that they are learning from. This is something that even adults struggle with: Evaluating the credibility of a source is difficult, as there are many cues, often competing, that one needs to take into account. Furthermore, sometimes sources are difficult to identify (for example, for information posted on the internet), making the evaluation of the source's credibility even more difficult. As mentioned earlier, very young children are notoriously poor at explicitly tracking the source of information that they have learned (e.g., Gopnik & Graf, 1988); however, the fact that children can at least implicitly track individuals' records of accuracy and use that information in a flexible way to moderate their selective learning suggests that abilities for developing critical thinking are in place very early on. Educators may be able to capitalize on the abilities that children possess in order to develop age-appropriate ways to teach children how to more effectively evaluate sources of information. Such teaching should have a long-lasting impact on children's future ability to, for instance, decide between competing accounts of scientific concepts such as the origins of species; differentiate between valid science and pseudo-science; and critically evaluate potentially biased information, such as that conveyed in advertisements.

In education, it may be desirable to increase children's trust (in credible sources) in order to maximize their learning. In other areas, however, it may be desirable to *decrease* children's propensity to unquestioningly accept information. One example is the issue of children's eyewitness testimony in legal settings. Research on this topic has demonstrated that individuals who provide testimony are at risk for inadvertently incorporating inaccurate information suggested by interviewers into their eyewitness accounts. This risk is even greater in young children: Many studies have found that the younger the child, the greater the likelihood that their eyewitness accounts will be modified by information provided by an interviewer (see Ceci & Bruck, 1993, for a review). This may be due to their propensity to trust adults and to their poor source monitoring. Potentially, if child interview procedures integrated insights from research on children's use of knowledge cues in order to highlight the fact that the interviewer is ignorant of the true facts, children might be less likely to fall prey to inadvertent suggestions. At least one study (Lampinen & Smith, 1995) has indeed shown that preschool-age children are more suggestible to misleading information when that information is presented by a credible adult than by a child or by an adult who has been discredited, suggesting that cues to knowledge may have an important impact on children's suggestibility (see also Warren, Hulse-Trotter & Tubbs, 1991). Recent research on children's use of knowledge cues, including that presented in the present document, will facilitate the development of applications in this field.

Strengths, limitations and future directions

As with all research, there are some limitations to the experiments presented in the preceding chapters. One limitation is that this research used a very specific paradigm to test children's use of past accuracy, a paradigm that, as mentioned above, has received some criticism. Specifically, Lucas and Lewis (2010) have expressed concern that children may view an individual who makes egregious and inexplicable mistakes as strange and thus refrain from learning from that individual, but that this does not indicate in any way that children are reasoning about his or her knowledge. However, as argued in Chapter 4, the fact that children do *not* use past accuracy equally in all situations is informative and suggests that children are being more sophisticated in their use of accuracy than such an account would predict. For instance, findings from Chapter 4 (i.e., that children who witnessed an individual with a history of inaccuracy were willing to accept that individual's information about the visual identity of an object but not that individual's information about the labels for objects) are difficult to explain under Lucas and Lewis' (2010) account and other non-epistemic accounts. If children were treating the individual as strange and were simply avoiding learning from that individual, one would expect them to refrain from learning from that individual in all contexts. Additionally, the present research used several small variations of the past accuracy paradigm (one versus two speakers; presence of a different type of information source; test objects presented as pictures on paper or on a computer screen, as live objects, or as hidden objects; presence of a second knowledge cue in addition to past accuracy) and found consistent effects over these variations. This renders less likely the possibility that findings were due to any specific procedural detail and strengthen the validity and generalizability of the conclusions.

The present research mainly focused on the use of a single knowledge cue, namely past accuracy (with the exception of Experiment 7, which also assessed children's use of visual access to information). It would be interesting for future research to further investigate children's use of other knowledge cues. There is evidence from past research (e.g., Jaswal & Neely, 2006; Tenney et al., 2011), that children do not use all knowledge cues the same way. Similarly, in Experiment 7 of the present dissertation, children varied their use of past accuracy given the type of information presented but clearly considered a cue such as information access to be important even in cases where they disregarded past accuracy. Future research could investigate different cues (e.g., verbal and nonverbal markers of confidence) in otherwise identical situations to better understand the ways in which children differentiate knowledge cues. It would be especially interesting to test whether children's use of different knowledge cues is consistent with the actual predictive value of these cues.

Future research could also investigate other factors, not examined in the present research, that have the potential to moderate whether children use a specific knowledge cue. The studies presented here focused mainly on variations in the type of information being learned; however, many other factors are likely to moderate children's attention and their use of knowledge cues. Some factors may make children more attentive to cues of speaker credibility. For instance, being presented with implausible or surprising information has been found to make children more likely to be skeptical of a speaker showing signs of unreliability (e.g., Jaswal & Malone, 2007). Other factors that may potentially increase children's sensitivity to informant (un)reliability include, for instance, the costliness of being wrong (for instance, it may be fine to be credulous when learning false information has few consequences, but more important to be savvy in a life-or-death situation), as well as the presence of conflicting sources of information (having different sources providing clearly contradictory information may probe children to think about reliability cues that they would not otherwise have considered). Other factors may make children less likely to be skeptical: For instance, pedagogical cues (i.e., cues that signal to the child an informant's intent to teach them something) may make children less likely to critically evaluate the information they are learning, as in findings of overimitation (e.g., Lyons et al., 2007).

Another open question that warrants further investigation is the mechanisms by which children come to understand which knowledge cues to use in what situations. By age 4 or 5, children may very well have learned quite a bit about natural variations in knowledge, either by being sensitive to the knowledge of people around them or from explicit teaching by their parents or others. It is also possible that children naturally expect knowledge to cluster in certain ways. How children come to making these distinctions is not currently known. Future research might test the role of experience by exposing children to situations where individuals vary in knowledge about novel types of information. By manipulating how individuals' expertise pertaining to novel information clusters, one might be able to test whether children can pick up on these variations and use them when encountering a novel individual. One could also see whether younger preschoolers can be trained, via similar manipulations, to make the same generalizations and distinctions as older children as a way of teasing apart the contributions of maturational age versus the role of experience which is typically confounded with age. Though this may seem ambitious, the fact that even infants can pick up on covariation information after very short exposure to novel stimuli (e.g., Saffran, 2003; Wu, Gopnik, Richardson & Kirkham, 2011; Younger & Cohen, 1986) certainly suggests that it is possible for the effect of experience to manifest itself in the context of a typical laboratory experiment. However, such an experiment would not be able to pick up on the effect of long-term exposure to natural variations in knowledge, and it is possible that children need extensive exposure to these natural variations (this, in fact, would partly explain why younger preschoolers are less likely to generalize knowledge across areas).

The experiments presented here only tested a narrow age range. This is partly due to the methods used, which works best in preschool-age children: Younger children are unable to follow verbally-demanding paradigms, and older children may be unlikely to cooperate in a study that appears too easy or "baby-ish" for them. Yet, investigating this specific age group was not a methodological accident; rather, the preschool and early school years are a time where a great deal of development occurs in theory of mind. Though recent research has shown that a number of aspects of theory of mind are in place in infancy (see Luo & Baillargeon, 2010, Meltzoff, 2011, Sodian, 2011, and Wellman, 2011, for recent reviews), children's ability to reason about mental states and use this understanding in a sophisticated manner undergoes a great deal of change in the late preschool years (see Harris, 2006; Pillow, 2012; San Juan & Astington, 2012, Wellman, 2011). Therefore, this age range is of special interest for the investigation of children's developing understanding of the predictive value of knowledge cues. Of course, studying developments in this understanding throughout the lifespan would also be of interest.

It is extremely difficult to design studies that work across a very broad age range (though not impossible: see for instance Bernstein et al., 2004). If such studies could be designed, it would be extremely interesting to investigate how the use of knowledge cues changes beyond the early school years. There is plenty of research showing that adults are sensitive to a variety of credibility cues when acquiring information from others (e.g., Dodd & Bradshaw, 1980; Hovland & Weiss, 1951; Smith & Ellsworth, 1987). A few studies have investigated developmental trends in older children's and adults' understanding of knowledge (e.g., Danovitch & Keil, 2007; Keil et al., 2008; Tenney et al., 2011). Future research could assess how the effects demonstrated in the present dissertation vary across a broader range of development. One might expect that older individuals would become increasingly sensitive to similarities and differences in areas of knowledge; become more likely to generalize accuracy across types of information that share fundamental (as opposed to trivial) properties, and less likely to generalize across more distant areas of knowledge; and become better at deciding which knowledge cues predict what types of knowledge. This might lead to an inverted u-shaped developmental trend in children's generalizations: Children's propensity to generalize past accuracy to a wide variety of situations might increase during the preschool years, as demonstrated in Chapter 2, but might subsequently decrease as children refine their understanding of the distinction between different areas of knowledge. For instance, we may expect adults to be less likely than young children to generalize between knowledge of natural sciences and knowledge of social sciences, as adults understand that these areas of knowledge are disparate and that expertise in one of these areas does little to predict knowledge in the other area. Experiment 4 (in Chapter 3) showed potential evidence for such a narrowing in the early school years, though the findings were the result of exploratory analyses and were too weak to be conclusive. Future research may be designed to specifically investigate whether such a narrowing truly exists.

At the other end of the developmental spectrum, there is ample research showing that sensitivity to some knowledge cues is present in infancy (e.g., Baldwin & Moses, 1996; Onishi & Baillargeon, 2005; O'Neill, 1996; Pea, 1982). Chapter 2 demonstrated that 3-year-olds are less likely than older children to generalize accuracy across areas of knowledge; however, this finding should be taken with some caution, as verbal paradigms often underestimate young preschoolers' abilities. Hence, while the present research demonstrates an increased likelihood of using past accuracy across areas in the late preschool years, they do not conclusively demonstrate that younger children are incapable of ever generalizing accuracy. Adapting the present research to make it appropriate for infants and toddlers could better determine if the present findings are specific to this paradigm or whether they indicate a true reluctance to generalize (in)accuracy in early childhood. This would lead to a better understanding of very young children's selective trust and their conception of the mind, which are extremely important areas given the sheer amount of social learning that happens during the first few years of life.

One additional question not investigated in the present research is that of cross-cultural variations. The nature and breadth of children's knowledge attributions is likely to be a culturally-sensitive phenomenon. Indeed, research with adults shows that the propensity to make dispositional attributions is more prevalent in western societies than in other societies (e.g., see Choi et al., 1999, for a review). By age 3 or 4, children have already learned quite a lot about their culture, and their attributions are likely to be influenced by the prevalent ideas about what knowledge is and how it is distributed in different individuals. Hence, children in our sample may, for example, be more likely to show generalization of accuracy across situations than children in some other cultures. Clearly, current findings should not be considered as universal patterns until further research investigates cross-cultural variations in children's use of knowledge cues.

Conclusion

In sum the present research demonstrates that older preschoolers and young school-age children are appropriately selective in their use of knowledge cues across a variety of situations, suggesting a rather sophisticated and nuanced grasp of principled distinctions in reasoning about knowledge as both a mental state and a psychological trait. They do not indiscriminately use all possible knowledge cues at all possible times; nor do they excessively restrict their use of knowledge cues, at least beyond age 3. On the contrary, children appear to be savvy in their use of past accuracy and use it to a greater extent when it is most likely to be relevant.

These findings provide the first steps in determining what cues moderate children's use of a person-specific knowledge cue, in this case past accuracy. These findings have several important implications and advance research on children's developing understanding of knowledge. The findings revealed in the seven experiments included in this dissertation will hopefully fuel further research and attention to an area that has captivated researchers for decades but is still ripe for investigations.

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