**(Over)Estimating Shared Cultural Knowledge:
Evidence for early use of a knowledge prediction heuristic in children**

By

Laura Grace Anderson

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Abstract

Both adults and children accurately and efficiently predict what other people know, despite interacting with a diverse range of individuals who each have different knowledge sets. To reduce the cognitive cost of predicting each individual's knowledge, there is evidence that we use heuristics to make generalisable predictions about the way specific kinds of knowledge are shared with others. Yet, little research examines the function of a knowledge prediction heuristic, the input needed to produce accurate knowledge predictions, or changes across development. I propose that children use a heuristic to predict others' knowledge, and that this heuristic functions by considering the type of knowledge being predicted, and characteristics of the individual whose knowledge is being predicted. Chapter 2 demonstrates that 3- to 6-year-old children accurately and selectively predict who shares different pieces of their knowledge. Children also predict knowledge accurately in a third-party task, providing evidence for the use of a generalisable heuristic rather than simple associations or personal experience. Chapter 3 and Chapter 4 demonstrate knowledge overestimation errors, predicted by the heuristic I propose. 4-year-olds, but not 6-year-olds, overattribute knowledge to others if the knowledge item being predicted is an example of a cultural knowledge item (typically shared with strangers from the same social groups). Yet, even 4-year-olds do not make this over-attribution error when predicting an example of a typically episodic knowledge item (not typically shared with any strangers). Chapter 4 provides initial evidence that feelings of closeness or shared episodic knowledge with a partner (but not simply shared group membership) decrease 4- and 6-year-olds consideration of this partner's perspective. Taken together, these findings provide evidence for an early-emerging knowledge prediction heuristic which considers the type of knowledge being predicted and characteristics of the individual whose knowledge is being predicted to facilitate accurate yet efficient knowledge predictions.

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Chapter 1

General Introduction

Though we can never access the content of another's mind directly, we are remarkably able to predict what other people know. A student asks their lecturer a question because the student predicts their lecturer will know the answer. You might have asked a local for directions, predicting that they will know where to direct you. We predict others' knowledge in less explicit ways too, by making inferences about what a communicative partner will understand or selecting specific words to explain a concept. When inviting someone to your house for the first time, you would usually provide them an address. Yet you would not do this each subsequent time you invited this person around, understanding that this specific person now knows where 'your house' is. While saying that humans can read others' minds is farfetched, adults do accurately predict the knowledge of others regularly (Nickerson, 1999; Royzman et al., 2003). Each of these situations requires us to predict what someone else knows and then adapt how we communicate with others based on our knowledge predictions.

Predicting other people's knowledge is an inferential challenge. Every individual that you encounter has a different knowledge set as a result of individual life experiences, meaning that we must tailor our knowledge predictions at an individual level. Beyond that, each day every person that you know has new experiences, does new things, and learns new information. Moreover, we learn new information and have new experiences ourselves too, yet we often must decide which pieces of new information are also known by those around us. Thus, the process we use to decide whether someone else knows something must be constantly updating. Furthermore, we often interact with strangers and, by definition, we possess little information about a stranger's knowledge set. Yet, it is entirely possible to have

smooth interactions with strangers which do require a consideration of their knowledge (e.g., asking a stranger for directions).

Though challenging, it is important that we predict others' knowledge accurately. During a communicative interaction, we need to consider a partner's knowledge in order to provide just enough information to convey our message. Not providing enough information for a partner to understand your message may result in confusion and providing excess information is inefficient and can be seen as patronising (Epley et al., 2004; Grice, 1957, 1969, 1975, 1978; Savitsky et al., 2011). For example, asking a Zookeeper where to find your 'favourite animal' overestimates this Zookeeper's knowledge, because a stranger is unlikely to know anything about your animal preferences. Conversely, explaining to a Zookeeper that tigers are big orange cats with black stripes underestimates this Zookeeper's knowledge and may come across as condescending. Importantly, the adequate amount of information to present depends on your partner's knowledge state, meaning that you need to consider each individual's knowledge set and tailor our communication accordingly. You may explain what an 'action potential' is to someone who had never studied psychology but not to a psychology professor. Adults regularly follow these communicative principles (Noveck & Reboul, 2008; Okanda et al., 2015; Panzeri & Foppolo, 2021; Van der Henst & Sperber, 2004), and even 5-year-old children show an early recognition and adherence to these ideas (Morisseau et al., 2013), suggesting that they make predictions about others' knowledge to evaluate what constitutes an informative (rather than over- or under-informative) utterance.

There is a wealth of research suggesting that adults can flexibly make predictions about others' knowledge in a variety of situations (Clark et al., 1983; Epley et al., 2004; Isaacs & Clark, 1987; Nickerson, 1999), and do so quickly during communication (e.g., Heller et al., 2012; Köymen et al., 2016; Krauss & Fussell, 1991; Wyman et al., 2009). Adults selectively use words that they predict their communicative partner will understand

(e.g., Brown-Schmidt & Hanna, 2011; Heller et al., 2012; Metzling & Brennan, 2003), and use information a partner brings up during a conversation to predict other things this partner knows (i.e., if someone expresses knowledge of a place in New York, adults will generalise this knowledge to knowledge of other New York locations; Isaacs & Clark, 1987). Adults can also predict some pieces of a stranger's knowledge (e.g., their expertise, knowledge of cultural figures and locations; Clark et al., 1983; Isaacs & Clark, 1987) highlighting the breadth of our ability to make knowledge predictions, even when lacking any prior experience with someone's individual knowledge set. Though there is evidence suggesting that adults regularly predict others' knowledge in order to communicate effectively and efficiently, we begin to communicate with others at a very young age. Are young children also predicting others' knowledge and use these predictions during communication? How do we develop the ability to predict what others know?

How do we predict others' knowledge?

Keeping track of the knowledge set for every individual we encounter would be a cognitively costly process. Each individual knows countless pieces of information and storing a log of which individuals share which pieces of information with ourselves would be immensely inefficient. Tracking others' knowledge would also not explain how adults are so readily able to predict the knowledge of complete strangers. Additionally, it is essential that we are able to predict others' knowledge quickly because we are often required to predict knowledge while communicating with others (Rubio-Fernández et al., 2019; Westra & Nagel, 2021), meaning that efficiency is often necessary when making knowledge predictions. Needing to consider whether each individual knows each piece of knowledge raised during a conversation (i.e., reasoning about whether and how this individual may have had access to each piece of knowledge you want to raise, rather than working under general guidelines or assumptions about what people like this individual typically know) would be a time-

consuming process and would undermine the efficiency benefit of considering others' knowledge during our communicative interactions. Instead, it seems like some kinds of information can be predicted using information about the individual whose knowledge is being predicted (i.e., where they live, their occupation; Aguiar et al., 2012; Isaacs & Clark, 1987; Soley & Aldan, 2020), meaning that you can predict the knowledge of this individual without needing to keep track of whether they know a specific piece of information. For example, you could predict that your neighbour knows the national anthem because you remember hearing this particular neighbour singing it before a sports game, or you could simply predict that this neighbour knows the national anthem because most people know the national anthem of the country that they live in. The latter prediction will also generalise to other individuals, meaning that you need to store exponentially less information about your experience with every individual's knowledge set in order to produce the same knowledge prediction.

When required to make quick predictions, using a heuristic can allow us to consider the relative probability of an outcome efficiently with only minor reductions in accuracy (Tversky & Kahneman, 1973, 1974). Some researchers have theorised that adults use specific mental shortcuts (heuristics) to help us predict knowledge. Nickerson (1999) suggested that we attribute all of our own knowledge to others (anchoring) and then subsequently adjust our predictions by considering how characteristics of this individual may be indicative of their knowledge set (e.g., removing personal knowledge specific to yourself but attributing knowledge a teenager or a pianist typically has). Harris (1992; see also Tamir & Mitchell, 2013) argues that instead of attributing all of our own knowledge to others first, we imagine ourselves in another individual's shoes and simulate which knowledge we would still predict ourselves to have if we were in this individual's position. Keysar and colleagues (1998) suggested that we may adjust our working models of a communicative partner's knowledge

when we detect violations of common ground (when a communicative partner refers to something that we had not assumed was shared knowledge) to adjust our working predictions about this partner's knowledge set.

Though these theories highlight why using a heuristic may be useful for making efficient knowledge predictions, not all knowledge can be predicted in the same way and these theories do not account for differences in how we come to possess knowledge and thus how knowledge can be predicted. There are different types of knowledge which are typically learned and shared in distinct ways (see Cimpian & Scott, 2012; Clark, 1996; Nickerson, 1999; Royzman et al., 2003). For instance, we acquire 'episodic knowledge' (similar to Clark's 'personal common ground'; Clark, 1996) through our individual life events and experiences. Knowing what you ate for breakfast and what you did after work yesterday are examples of episodic knowledge items. Because episodic knowledge refers to knowledge of specific events or experiences, it is typically only known by people who have had access to it (either direct access via being present, or indirect access via being told about it), meaning that knowledge access is important to consider when predicting shared episodic knowledge. In contrast, what we might call 'cultural knowledge' (or 'cultural common ground', Clark, 1996) is typically shared by members of the same social groups and communities. However, cultural knowledge is not typically shared by individuals who are not members of that social group or community, meaning that these social group memberships are important to consider when predicting shared cultural knowledge. Examples of cultural knowledge items could include Wellingtonians knowing what 'Te Papa' is, or musicians knowing how to count in a 3/4 time signature. Because each individual is a member of a multitude of different groups at any given point in time (I can be a New Zealander, a psychological scientist, and a music lover at the same time), any individual will have multiple pieces of cultural knowledge associated with the numerous social groups they are a part of. There are other types of

knowledge as well, for instance procedural knowledge (e.g., knowing how to read or ride a bike) acquired through learning experience, or general knowledge (e.g., knowing that the sun rises in the morning or that grass is green) which most people around the world are likely to have, regardless of their background or the social groups and communities they are a part of. Given that the way general and procedural knowledge are shared with others is different from episodic or cultural knowledge, we likely need to consider different information (e.g., age) or guidelines (e.g., everyone has this knowledge unless you receive information that predicts otherwise) to predict who shares general or procedural knowledge.

Though researchers have theorised that adults use mental shortcuts to facilitate efficient and mostly accurate knowledge predictions (e.g., Harris, 1992; Keysar, 2007; Nickerson, 1999), the proposed heuristics do not explain how we decide which information to consider given the type of knowledge being predicted. Though using the information that an individual is a lawyer may be useful in predicting their legal knowledge, this is not helpful when predicting their episodic knowledge, general knowledge, or other types of cultural knowledge (e.g., country specific knowledge). In order for a heuristic to predict who shares different types of knowledge, this heuristic must consider which type of knowledge is being predicted (e.g., episodic, cultural), how this type of knowledge is typically shared (e.g., through observable access, by shared group membership), and then make generalisable predictions about whether an individual possesses this knowledge based on the information that is relevant to that type of knowledge.

Additionally, the heuristics proposed (anchoring and adjusting; simulation) appear to rely on lots of experiences with a diverse range of individuals in order to have an understanding of the ‘typical knowledge sets’ that different groups of people have before these can be used to facilitate future knowledge predictions. Adults may simulate or adjust what they predict themselves to know if they had a specific characteristic (e.g., a

Wellingtonian), but this simulation appears to require that adults already have a concept of the knowledge that a typical Wellingtonian has (as in Harris, 1992, Nickerson, 1999). Thus, it is possible that predicting others' knowledge requires children to gain experience predicting which kinds of people generally have a specific piece of knowledge in order to start making predictions about the way that specific piece of knowledge is shared with new social partners. For example, a child who lives in Wellington may begin by assuming that everyone in the world knows Wellington-specific knowledge, and only begin to adjust these predictions when they encounter people who do not share this information. These experiences may build up throughout childhood and allow children to begin to adjust their knowledge predictions when they grow older. However, an alternate possibility is that from a young age, children already use specific cues or pieces of information to make generalisable and updateable knowledge predictions. For example, children may already have intuitions about the kinds of knowledge items that are typically shared by people who live in the same place and use these general rules to adjust their knowledge predictions for knowledge that they predict a Wellingtonian might have.

In particular, studying cultural knowledge provides an interesting test of the process that children use to predict others' knowledge. If children simply associate specific individuals with the knowledge that they have had observable access to (as is possible for episodic knowledge), children should struggle to accurately predict cultural knowledge. Children may even predict that those who should have cultural knowledge do not have it, because we often do not observe others learning pieces of cultural knowledge. However, it is also possible that children do make accurate cultural knowledge predictions in which they selectively attribute cultural knowledge to members of the group it is associated with, even when children do not have information about knowledge access. If children do predict cultural knowledge using the heuristic I propose, children will need to consider how social

group information and information about the knowledge item being predicted interact in order to produce cultural knowledge predictions. That is, in order to accurately predict cultural knowledge without any information about knowledge access, children must understand that cultural knowledge is typically shared within social groups, have intuitions about the kinds of things that are cultural knowledge, and make predictions about who possesses knowledge based on their social group memberships. Do children predict others' cultural knowledge?

Do children predict what others know?

Young children and even infants appear to have some understanding of the role of shared knowledge in communicative interactions (e.g., Epley et al., 2004; Nadig & Sedivy, 2002), suggesting that the process we use to consider others' knowledge may have foundations early in development. Infants between 14- and 24-months use contextual information about their partner's knowledge (i.e., what their partner can see, has seen, or has engaged with previously) to resolve an ambiguous communicative request (Ganea & Saylor, 2007; Liberman, Woodward, Keysar, et al., 2017; Moll & Tomasello, 2006; Saylor & Ganea, 2007) and when young children are told what a communicative partner knows, children modulate the amount of information they provide in later conversation (Baer & Friedman, 2018; Bass et al., 2019). For instance, when told that their partner knew a lot about cups, 4-year-olds referred to specific and unique properties of the cup present (e.g., "Cup has dots. Cup has a handle"). However, if children were told their partner was unfamiliar with cups, 5-year-olds referred to general characteristics of cups first (e.g., "Cup is like how you drink stuff"; Baer & Friedman, 2018, p.6). Further, there is some evidence that children consider which items are visible to both themselves and their communicative partner (which items are in visual common ground; Clark, 1996) from the earliest stages of language processing (Nadig & Sedivy, 2002), showing an early consideration how referential cues (e.g., what is

mutually visible) could indicate shared knowledge and give a clue to what someone is talking about.

There is evidence that young children can predict a social partner's episodic knowledge. Infants consider perceptual access, such as what someone can see, to make inferences about an episodic event (Ganea & Saylor, 2007; Liberman, Woodward, Keysar, et al., 2017; Moll & Tomasello, 2006; Saylor & Ganea, 2007) and three-year-olds expect peers to adhere to the rules of a game if they were present when the rules were explained but did not expect adherence from peers who were not present for the explanation and therefore lacked a shared understanding of the rules (Wyman et al., 2009). Children also reiterate episodic knowledge to someone who was absent when the information was taught (Köymen et al., 2016), and understand that someone will not understand a novel label if they were not present when this label was coined (Köymen et al., 2014; Matthews et al., 2010). Because having episodic knowledge relies on presence during an event or being subsequently informed about an event, to predict episodic knowledge accurately children only need to recall and interpret this information. That is, predicting episodic knowledge requires children to make an inference about knowledge state based on access to an event. Further, because sharing a piece of episodic knowledge often involves two people sharing an event or experience, a person's access to this information is often directly observable. Children understand that access to a piece of episodic knowledge is required to 'know' it (Miller et al., 2003; O'Neill et al., 1992), and, further, understand that we cannot know unobservable things unless we have another form of access to them (i.e., being told by a reliable source; Koenig et al., 2015; Lockhart et al., 2016; Mahr et al., 2020).

It is not possible to predict all kinds of knowledge by solely considering who was present when a piece of knowledge was discussed. Cultural knowledge is widely shared among people within the same social groups and communities, meaning that you could share

cultural knowledge with complete strangers if they were in the same social group as yourself (Clark, 1996). Though these individuals must have had access to cultural knowledge at some point in order to know it, we often cannot use information about knowledge access to predict cultural knowledge in the same way that we can for episodic knowledge. Thus, predicting cultural knowledge presents a more inferential challenge because we do not often observe others accessing cultural knowledge but instead make inferences about whether it is likely someone has a piece of knowledge given characteristics about them (such as their social group or community memberships). For example, I could predict that a stranger from Wellington knows what ‘The Beehive’ is by considering the social groups that this stranger is a member of (Wellingtonians) and the knowledge items that a typical member of this social group would know (The Beehive). Importantly, I can make this cultural knowledge prediction without knowing how this stranger came to know what ‘The Beehive’ was (i.e., without any information about this stranger’s knowledge access), highlighting a necessary distinction in how children need to predict episodic and cultural knowledge.

Can children predict others’ cultural knowledge?

To predict cultural knowledge using the heuristic I propose, children will need to recognise important markers of social group membership and also understand how those social group memberships license cultural knowledge predictions. From early in development, infants and young children view social group information as important to attend to. Infants prefer individuals who have the same preferences as themselves (Mahajan & Wynn, 2012), selectively pay attention to information from people who speak their native language (Buttelmann et al., 2013; Marno et al., 2016), and expect some preferences and opinions to be markers of social group membership (e.g., food preferences; Liberman et al., 2016). In early childhood, children begin to make richer inferences about group membership, with four- to five-year-olds using language (Kinzler, Corriveau, & Harris, 2011; Souza,

Byers-Heinlein, & Poulin-Dubois, 2013) and accent (Floccia, Butler, Girard, & Goslin, 2009; Weatherhead, Friedman, & White, 2018; Weatherhead, White, & Friedman, 2016) to predict someone's geographic location. Infants and young children prefer speakers of their native language over speakers of other languages (Kinzler, Dupoux, & Spelke, 2007), and even preverbal infants expect speakers of the same language to affiliate with each other (Lieberman, Woodward, & Kinzler, 2017). This literature also demonstrates which kinds of information infants and young children view as indicative of group membership. Infants and young children appear to view language, accent, and geographic location as markers of social group membership (Kinzler et al., 2007, 2011; Liberman, Woodward, & Kinzler, 2017; Souza et al., 2013; Weatherhead et al., 2016; Weatherhead, Friedman, et al., 2018; Weatherhead, White, et al., 2018), and expect some types of shared preferences to indicate that people will affiliate (e.g., food preferences; Liberman et al., 2016; Shutts et al., 2009, 2013).

Some research suggests that children understand these markers of social group membership may be related to cultural knowledge (Goldvicht-Bacon & Diesendruck, 2016). Like adults, 5- and 6-year-olds predict that those who speak the same language are more likely to share knowledge of a song than those who speak different languages (Soley & Aldan, 2020), and 5-year-olds expect a stranger to know about cultural figures (i.e., Santa Claus) but not novel figures (i.e., "the sandman"; Liebal et al., 2013). However, we do not yet know whether children understand not all shared group membership results in the same kinds of shared knowledge (i.e., being from the same location may increase your likelihood of having location specific cultural knowledge but does not increase your likelihood of having episodic knowledge or cultural knowledge associated with other social groups) or that children treat cultural knowledge as selectively shared with only members of the social group it is associated with. For example, being a New Zealander may mean that you know cultural knowledge associated with being a New Zealander (e.g., New Zealand slang, local

landmarks, foods typically available in New Zealand, New Zealand songs) but it should not provide any information about shared episodic knowledge (e.g., favourite colours, personal life facts), nor other kinds of cultural knowledge (e.g., occupation specific knowledge, skill sets, family specific knowledge). Additionally, while 5-year-olds assume that a stranger would know a cultural figure (Santa Claus) but not a novel figure (The Sandman), we have no information that suggests children do not simply view Santa Claus as general knowledge. That is, knowledge everyone in the world is likely to have. If children are using this heuristic to predict cultural knowledge, children need to recognise which kinds of social groups license the attribution of cultural knowledge, and which kinds of knowledge items are examples of cultural knowledge associated with those groups.

Interestingly, it does seem that children have robust intuitions about the kinds of items that are typically shared within social groups and communities from an early age. Infants expect people who speak the same languages to share food preferences (Lieberman et al., 2016) and will choose to eat foods that have been endorsed by native language speakers over foreign language speakers (Shutts et al., 2009, 2013). Native language appears to be an important marker of group membership, with infants both preferring speakers of their native language and expecting to receive knowledge from them (Begus et al., 2016). 5- to 6-year-old children expect songs to be selectively known by speakers of the same language (Soley & Aldan, 2020) and infants prefer songs presented by those who speak the same language as the infant (Soley & Sebastián-Gallés, 2015). Some researchers also suggest that stories are a cultural knowledge item (Király et al., 2017; Tsosie, 2002), due to their importance in transmission of culture throughout generations. These intuitions about items that are typically associated with social groups are different from predicting cultural knowledge, as many of these studies examine shared preferences within social groups or increased attention towards members of the same social group rather than examining knowledge predictions. However,

these studies do provide some evidence that infants and young children may already be forming intuitions about the kinds of knowledge items that are typically associated with different social groups.

What process do children use to predict others' knowledge?

Given the evidence that infants and young children can predict how some types of knowledge are acquired (e.g., episodic knowledge; Köymen et al., 2016; Moll & Tomasello, 2006; Wyman et al., 2009), already have intuitions about the kinds of items that are associated with different social groups (Begus et al., 2016; Floccia et al., 2009; Király et al., 2017; Liberman et al., 2016; Liberman, Woodward, & Kinzler, 2017; Liebal et al., 2013; Shutts et al., 2013; Soley & Sebastián-Gallés, 2015; Weatherhead et al., 2016; Weatherhead, Friedman, et al., 2018), and show some indications of understanding the importance of integrating knowledge into communicative interactions in order to communicating effectively and efficiently (Baer & Friedman, 2018; Bass et al., 2019; Nadig & Sedivy, 2002), I argue that children use a knowledge prediction heuristic to facilitate relatively accurate and efficient predictions of cultural knowledge predictions. I propose that children take information about others' social group memberships and intuitions about the kinds of knowledge items that are typically examples of cultural knowledge to make quick and generalisable knowledge predictions. I predict that this knowledge prediction heuristic must function by first considering which type of knowledge is being predicted, due to the difference in information required to predict different types of knowledge. For instance, children should use information about knowledge access to predict an individual's episodic knowledge but when predicting cultural knowledge should instead use information about social group memberships. Secondly, the heuristic must consider how information about a specific individual whose knowledge set is being predicted (e.g., social group memberships

when predicting cultural knowledge; knowledge access when predicting episodic knowledge) is predictive of their knowledge state.

How do we test whether children are using this knowledge prediction heuristic, which considers the type of knowledge being predicted and information about the individual whose knowledge is being predicted? Most convincingly, by virtue of a heuristic being a mental shortcut, using a heuristic will occasionally lead to errors. If we find evidence of a signature pattern of errors that children make when predicting cultural knowledge, we can determine whether children are in fact using the knowledge prediction heuristic I have proposed. Children may make interpretable knowledge prediction errors if a person's knowledge does not match what is typical for members of the social groups they are a part of (e.g., a person who has recently moved to New Zealand not knowing the New Zealand national anthem), or if the knowledge being predicted is not shared in a way that is typical for that kind of knowledge (e.g., knowledge of a lullaby that your parent created only being known by your family members, even though children typically view songs as widely shared among speakers of the same language; Soley & Aldan, 2020). While trying to consider knowledge access in any of these situations may lead children to underestimate an individual's knowledge set (because you often lack any information about an individual's access to cultural knowledge), using the heuristic I proposed may in fact lead to interpretable and predictable overestimations of knowledge. This distinction is important because it will highlight which kinds of information children are considering in order to predict others' knowledge. If children do not make a distinction between types of knowledge, we should see children using the same information to predict all types of knowledge (e.g., knowledge access), leading to underestimation errors when predicting cultural knowledge. This would also lead to children needing to predict every individual's knowledge using information about this individual's knowledge access each time a new knowledge item was raised, rather than being able to

make generalisable predictions about the way that different types of knowledge are shared with different kinds of people. However, if children do distinguish different types of knowledge and understand how the cues needed to predict different types of knowledge differ, we should instead see accurate estimations (or occasionally predictable overestimations) of who shares cultural knowledge.

The current studies

In this thesis, I will present three lines of work investigating whether children use the heuristic I have proposed in order to predict and generalise cultural knowledge, and I examine whether children reason about cultural knowledge distinctly from other types of knowledge (e.g., episodic knowledge, general knowledge, procedural knowledge). I predict that children must use information about the type of knowledge being predicted and information about the individual whose knowledge is being predicted in order to produce accurate knowledge predictions when using this heuristic. Using this knowledge prediction heuristic would also allow children to consider the knowledge of strangers, generalise knowledge within social group members, and predict how new pieces of knowledge are shared. By studying children, I remove a portion of the social and communicative experience that adults have, thereby examining whether a heuristic that identifies and generalises cultural knowledge across social group members can operate with limited knowledge prediction experience and social exposure to members of different groups. Additionally, I examine how children's knowledge predictions develop between 3- and 6-years-old in order to assess whether use of this heuristic changes in early development.

Chapter 2 demonstrates that 3- to 6-year-old children can selectively predict who shares their own cultural knowledge using information about social group membership and furthermore, predict which groups of strangers share novel cultural knowledge. I provide evidence that children do not treat cultural knowledge as general knowledge shared by

everyone, because children made selective inferences about which group members shared and did not share cultural knowledge. By assessing how children predict knowledge in both a first-party and third-party context, I also provide evidence that personal experience with a partner or a piece of knowledge is not necessary for young children to predict how it is likely to be shared with others. Instead, I provide initial evidence that children use a generalisable heuristic to predict cultural knowledge, which considers how pieces of cultural knowledge are typically associated with different social groups and highlights an early intuition about which kinds of knowledge items tend to be cultural knowledge.

Chapter 3 examines how using a heuristic to predict cultural knowledge may actually cause children to overestimate someone's cultural knowledge in interpretable ways. Chapter 3 demonstrates that 4-year-old children, but not 6-year-old children, overattribute knowledge of an item they have just created to a stranger, if the knowledge item is an example of cultural knowledge (knowledge that is typically shared, e.g., stories and foods). Importantly, even 4-year-olds accurately judge that a stranger would not know an item that participants had just created if the item was an example of typically episodic knowledge (and therefore not typically shared with strangers, i.e., episodic knowledge). This predicted overestimation error provides evidence that 4-year-olds use the knowledge prediction heuristic I propose to facilitate early knowledge predictions, as this overestimation error demonstrates an understanding of the way that different types of knowledge are typically shared (e.g., cultural knowledge is typically shared with people from the same social groups, but episodic knowledge relies more heavily on knowledge access). Chapter 3 provides further evidence that by 4-years-old, children have intuitions about the kinds of items that are examples of typically cultural and typically episodic knowledge.

Chapter 4 examines whether predicting shared cultural knowledge may lead children to overestimate how much episodic information is shared with a partner. Specifically, if the

knowledge prediction heuristic that children use predicts shared cultural knowledge with members of the same social groups and communities, this increase in amount of shared knowledge may cause children to overestimate which other pieces of knowledge are shared. I predicted that because children share more cultural knowledge with somebody from the same groups and communities than a member of different social groups, this increase in overall shared knowledge may lead to children overestimating how much other knowledge is shared, causing a reduced feeling of need to consider this individual's visual perspective. Because considering a partner's visual perspective is only necessary when we perceive a difference in our perspectives, I predicted that an increase in shared knowledge generally may cause children to also perceive more similarity in their perspective and their partner's perspective, thus causing perspective-taking errors when the two perspectives were not actually the same. The results of Chapter 4 find no perspective-taking differences when children communicated with a stranger from the same or a different social group, despite the increase in shared cultural knowledge with an individual from the same social groups and communities. However, Chapter 4 finds a trend which suggests that children may be worse at considering the perspective of their parent or caregiver (another form of group or community) than the perspective of a stranger. These marginal results provide reason to further investigate whether some kinds of community or group membership (but not other groups which also warrant an increase in shared knowledge) decrease our consideration of a partner's perspective.

In Chapter 5, I discuss how these results provide evidence for the early use of the knowledge prediction heuristic I propose, which considers both the type of knowledge being predicted and information about the individual whose knowledge being predicted to produce efficient and generalisable knowledge predictions. The research presented in this thesis provides evidence that children do consider the type of knowledge being predicted and characteristics of the individual whose knowledge is being predicted when asked to make

shared knowledge predictions. This empirical evidence suggests that children create conceptual boundaries between types of knowledge and have intuitions about the kinds of knowledge items that make up these knowledge types. The consistency in 3- to 6-year-old children's knowledge predictions suggests an early emerging knowledge prediction heuristic, but the age difference observed in Chapter 3 suggests that other variables (e.g., life experiences, other cognitive abilities like inhibitory control) may influence the function of this heuristic. Finally, I discuss open questions about this heuristic, including how to define conceptual boundaries between types of knowledge, the progression of this knowledge prediction heuristic to adulthood, and the development of spontaneous and unprompted knowledge predictions during communication.

Chapter 2

What do you know? Children predict shared cultural knowledge.

Abstract

How do we begin to make inferences about what others know? Though there is evidence that young children do consider others' knowledge, less is understood about the strategies children use to make knowledge predictions or the information that children use to inform the selectivity of these predictions. Three studies investigate how children use group membership to predict shared cultural knowledge. In Study 1, 3- to 6-year-olds ($n=38$) expected their own cultural knowledge to be selectively shared with others from the same geographic location, but predicted that general knowledge was not group-specific. In Study 2, children were asked to predict which groups of strangers would share novel pieces of cultural and episodic knowledge, thereby examining the role of personal experience in predicting others' knowledge. Three- to 6-year-old children ($n=80$) expected novel cultural knowledge (but also novel episodic knowledge) to be shared between strangers from the same location rather than those who are the same age. In Study 3, 3- to 6-year-olds ($n=40$) treated age as a more informative cue than location when predicting procedural knowledge, showing selectivity in the types of knowledge children expect to be shared within different social groups. Study 2 and 3 highlight that children do not require experience with a piece of knowledge in order to predict how it is shared, instead providing evidence for the use of knowledge and group membership information to produce generalisable predictions. Taken together, this research provides insight into the factors that influence children's early inferences on how knowledge is shared between groups.

Keywords: social cognitive development, cultural knowledge, shared knowledge, theory of mind, social groups

During many of our daily interactions, we need to quickly predict the knowledge of those we interact with. Simply communicating with others often requires a consideration of whether an individual will understand what you are discussing and the terms you are using to convey it. For example, we understand that asking a friend to stop by ‘your house’ only makes sense if this particular friend already knows where your house is. We might explain that ‘Te Papa’ is a local museum to family member overseas but not to a friend who also lives locally. Predicting the knowledge of those we interact with is crucial to facilitate smooth interactions, as overestimating or underestimating others’ knowledge can result in miscommunication and confusion (e.g., Keysar, 2007; Royzman et al., 2003). Because we each interact with a wide range of people who each share different pieces of our knowledge, it is important to be able make predictions about whether a specific piece of knowledge is likely to be known by the specific person we are communicating with. To complicate these predictions, each person we encounter has a unique knowledge set as a result of individual life experiences, making it an inferential challenge (albeit an important one) to predict a specific partner’s knowledge set.

While there is a wealth of research demonstrating that despite these challenges, both adults and children do consider the knowledge of those they interact with (e.g., Fussell & Krauss, 1989; Isaacs & Clark, 1987; Köymen et al., 2016; Moll & Tomasello, 2006; Nickerson, 1999; Wyman et al., 2009), we know less about *how* adults and children are making these predictions. Because adults have a wealth of experiences interacting with different individuals and different social groups, it is difficult to disentangle the role of experience in predicting others’ knowledge. It is possible that the ability to predict knowledge simply relies on consideration of previous interactions with an individual or observable cues to their knowledge state (i.e., knowledge access; see Lockhart et al., 2016; Miller et al., 2003). However, it is also possible that we make quick predictions about an

individual's knowledge state using information about the person themselves and the type of knowledge being predicted (Clark, 1996; Isaacs & Clark, 1987; Nickerson, 1999). How do we selectively predict which knowledge is shared with which individuals?

One factor that appears to influence how we predict shared knowledge is the type of knowledge in question. Some knowledge is widely shared with almost everyone because it is generally accessible or observable (e.g., grass is green, clouds appear in the sky).

Understandably, children therefore predict knowledge presented in a generic and factual way to be widely shared (Cimpian & Scott, 2012; Prasada, 2000; Sutherland & Friedman, 2012).

Other knowledge is shared by far fewer people or even known by only one individual, such as episodic knowledge (knowledge gained via a particular episode or life experience is only shared by those who were present during the episode or learned about it via communication).

Even children as young as age 3 recognize, for example, that only those who were present to learn the rules of a game or facts about a novel animal would have knowledge of this information, while those who were absent would not (Köymen, Mammen, & Tomasello, 2016; Köymen, Schmerse, Lieven, & Tomasello, 2014; Wyman, Rakoczy, & Tomasello, 2009). We may also have knowledge that tends to be widely shared with some people but not others, and not by virtue of acquiring that knowledge via direct shared experience. This is often referred to as group-specific or cultural knowledge, referring to knowledge shared between members of the same social or cultural groups (e.g., knowledge of the types of music, food, norms, cultural icons, or practices of the group; Clark, 1996).

Predicting who shares your cultural knowledge is especially challenging, as each individual is a member of a huge number of social and cultural communities at any given time, but only certain kinds of group membership (e.g., where someone lives) license richer and broader inferences about shared cultural knowledge than others (e.g., whether someone is left-handed). Furthermore, it is only useful to consider cues of group membership if they

relate to the knowledge being discussed. For example, discovering that someone is from New Zealand may help in the estimation of New Zealand-specific knowledge, but is not useful when estimating a partner's knowledge of the rules of a new game. Because most members of a social group will share cultural knowledge, it is possible to share cultural knowledge with complete strangers if they are members of the same social group, thereby reducing the possibility to predict knowledge using personal experience or observable access. Therefore, the cognitive strategies people use to estimate shared cultural knowledge cannot be limited to considerations of direct access to information (e.g., I assume you know where my house is because we have talked about it, or you have been there before); we must also make broader inferences about the types of knowledge likely to be shared within specific groups.

Previous research has shown that adults do regularly use cues about the groups someone is a part of to predict their cultural knowledge (Nickerson, 1999). For example, adults were more likely to use the proper names of New York City landmarks in conversation if their partner was a New York local, whereas they were more likely to use descriptions of the landmarks with a partner who was not a local (Isaacs & Clark, 1987; also see Heller, Gorman, & Tannenhaus, 2012). How does the ability to make inferences about shared cultural knowledge develop? From a very early age, infants attend to group membership cues, including language (Buttelmann, Zmyj, Daum, & Carpenter, 2013; Marno et al., 2016), food preferences (Liberman, Woodward, Sullivan, & Kinzler, 2016), and even somewhat arbitrary groupings such as clothing colour (Mahajan & Wynn, 2012). Four- to five-year-olds also regularly use cues of cultural group membership like language (Kinzler, Corriveau, & Harris, 2011; Souza, Byers-Heinlein, & Poulin-Dubois, 2013) and accent (Weatherhead, Friedman, & White, 2018; Weatherhead, White, & Friedman, 2016) to predict someone's geographic location, and to guide their own social preferences for ingroup members (Floccia, Butler, Girard, & Goslin, 2009; Kinzler, Dupoux, & Spelke, 2007).

Furthermore, infants and children use cultural group membership information to predict other features or behaviour that might be shared by group members. For example, 14-month-old infants expect people who speak the same language to share food preferences, but do not generalise this expectation to people who speak different languages (Lieberman et al., 2016). By age 5 or 6, children expect people from the same linguistic group to share cultural practices, norms (Weatherhead, White, & Friedman, 2018), and knowledge of music (Soley & Aldan, 2020), but not personal preferences which tend to be more arbitrary (Weatherhead et al., 2016). These lines of research highlight that infants and young children value group membership information and can use it to form expectations about others and to inform some of their own social preferences and behaviours. We know less about how children use cultural group membership information to infer what types of knowledge group members do and do not share.

There is little research demonstrating that children understand how cultural knowledge is selectively shared within groups, but a few studies hint that children can use their own shared cultural knowledge with others to predict and interpret others' behaviour. Five-year-olds expect a cultural symbol they are familiar with (e.g., their country's flag) to be salient to another person from their own country, but not to someone from a different country (Goldvicht-Bacon & Diesendruck, 2016). Three-year-olds, like adults (Clark, Schreuder, & Buttrick, 1983), assume that when someone asks them for an object in a confused tone of voice rather than a tone of recognition, they are more likely to be referring to an unfamiliar character than a familiar cultural figure (Liebal, Carpenter & Tomasello, 2013). However, there is no evidence yet that children are not treating cultural knowledge as general knowledge (i.e., knowledge that everyone will know regardless of social group) but rather selectively predict that ingroup members will share cultural knowledge, yet outgroup members will not. Additionally, these few studies cannot tell us how children are considering

which kinds of ingroup members should share particular types of knowledge (i.e., would someone who is left-handed like you be equally likely to share your cultural knowledge as someone who is from the same country?), or whether they think all types of knowledge (not only cultural knowledge) are more likely to be shared with their ingroup. Understanding which kinds of information children use to make selective inferences about who shares their knowledge will provide information on the process that children employ to predict others' knowledge.

Study 1

The current studies investigate how young children predict the cultural knowledge of others. In Study 1, we examine 3- to 6-year-old children's predictions of who is likely to share their own cultural knowledge. Because predicting who is likely to share your knowledge is important throughout many early interactions (i.e., simply communicating with others), we are interested in whether young children are already beginning to consider how group membership cues might facilitate predictions about which knowledge is shared. Because previous literature has shown 3-year-olds make some inferences about the shared nature of cultural items (Liebal et al., 2013) and 5- to 6-year-olds make judgments about which type of group members are most likely to share knowledge of one cultural item (songs; Soley & Aldan, 2020), we tested children across this age range allowing us to examine how the ability to predict shared knowledge selectively develops. Beyond the developmental differences in considering others mental states that occurs within this age group (e.g., Taylor et al., 1994; Wellman et al., 2001; Wimmer & Mayringer, 1998), most children also start school or kindergarten between 3- and 6-years, allowing for interactions with a more diverse range of knowledge sets and backgrounds. It is possible that this experience interacting with people who do and do not share their knowledge may facilitate children's future knowledge predictions. However, it is also possible that even our youngest age group may already be

employing strategies which allow them to predict who shares their knowledge accurately and efficiently.

In Study 1, we ask whether children selectively predict that their own cultural knowledge will be shared by those from the same geographic location (a typical clue to cultural group boundaries) but understand that not all types of in group members should share this cultural knowledge (i.e., people who were given the same sticker or had watched the same TV show). Secondly, we ask whether children's predictions about who shares their cultural knowledge are selective – that is, whether children predict that only their in-group members share their cultural knowledge, but treat general knowledge as widely shared between groups.

If children understand that not all similarity information is a good cue for predicting shared cultural knowledge, we hypothesize that children should use relevant similarity cues to inform their estimations of cultural knowledge and should not use irrelevant or arbitrary cues to inform their predictions. In particular, if children recognize that people from the same place as them should share common cultural knowledge of that location, they should expect another child from New Zealand to share their New Zealand-based cultural knowledge but not other children who are similar in arbitrary ways. Secondly, if children recognize that someone from the same location is not just generally more likely to possess cultural knowledge, children should not expect the child from New Zealand to be more likely to possess non-New Zealand based cultural knowledge and may predict that the child who is not from New Zealand is more likely to possess such novel cultural knowledge. Third, if children understand that even a relevant similarity cue is not useful for predicting all *kinds* of knowledge, children should treat general knowledge and cultural knowledge differently, not using group membership cues to inform their general knowledge predictions.

Method

Participants. Thirty-eight 3- to 6-year-old children participated in this experiment ($M = 60.8$ months, $SD = 13.44$, range = 38.04 to 82.90; 18 females). We collected an equal number of children at each age but planned to treat age continuously to assess whether the selectivity of children's cultural knowledge predictions within appropriate social groups (i.e., those from the same location) increased with age. We aimed to collect data from 36 participants but while finishing data collection 2 additional children were run, so we included their data in the final sample. All participants were typically developing children living in a city in New Zealand, who indicated interest in participating in research on child development. Because we presented New Zealand-specific information, children needed to recognize that they lived in New Zealand and understand English to be eligible to participate. Data were collected between May and November in 2018. Three additional 3-year-olds and one additional 4-year-old were excluded for not following instructions or not answering test questions.

Stimuli and Design. Each participant was presented with four pairs of photos of Caucasian faces on a laptop taken from the Child Affective Facial Expression (CAFE) photoset (LoBue, 2014). The photos were gender matched to the participant, and the children in the photographs were all aged between 3 and 7, matching the age range of our sample (LoBue, Baker & Thrasher, 2017).

Study 1 used a 3x3 within-subjects design. We manipulated 3 types of similarity to the participant as cues of group membership: living in the same vs. a different place (location), familiarity with the same vs. a different TV show or book (TV show), or possession of the same vs. a different sticker (sticker). We asked about three different types of knowledge: commonly shared knowledge within the participant's location, New Zealand (familiar cultural knowledge, e.g., how to count to 10 in Te Reo Māori), novel cultural

knowledge from a fabricated location (novel cultural knowledge, e.g., how to count to 10 in Razoovet), and general knowledge which is not group specific (e.g., what colour grass is). The familiar cultural knowledge items were chosen based on their familiarity to the majority of people in the city and country where participants live, and uniqueness to that place (i.e., people from other places would likely not be familiar with them). The novel cultural knowledge items were created to match these items. The general knowledge items were facts that young children are familiar with, and which are readily seen by adults as common knowledge. See Table 1 in supplementary materials for a list of the similarity types and knowledge items used in Study 1.

Each participant answered one question of each possible similarity and knowledge combination, for a total of nine questions. The questions were blocked by similarity type so that the participants learned about a given pair of children, and then answered the 3 questions about that pair. Children were randomly assigned to one of nine conditions, such that a third of the participants received each similarity block and each type of knowledge question first. The side of the similar child was counterbalanced across blocks (3 knowledge questions) and the question order was counterbalanced within blocks, meaning that each of the 3 question types could appear in each question position across conditions. The order of the specific pairs of photos was fixed meaning that across conditions, each child's photo was sometimes represented as the similar child and dissimilar child for each similarity type.

Table 1. *Knowledge questions (phrased as, “Who would know....”) and similarity facts used.*

<i>Knowledge Type</i>	<i>Item</i>
Similar Cultural Knowledge	...where the museum ‘Te Papa’ is? ...what ‘Poi’ are? ...how to count to 10 in the language ‘Te Reo Māori’?
Novel Cultural Knowledge	... where the museum ‘Razoovet’ is? ...what ‘Whogladore’ are? ...how to count to 10 in the language ‘Tiva Daxel’?
Generic Knowledge	...what colour grass is? ...how many fingers people have? ...what sound a dog makes?
<i>Similarity Type</i>	<i>Item</i>
Relevant (Location)	This kid lives right here in <i>City Name</i> , New Zealand. This kid lives far away in Gwyntibel, Silhicket.
Irrelevant (TV Show Knowledge)	This kid has watched/read [<i>tv program/book the child enjoys</i>]. This kid has watched/read ‘The Blodges’.
Arbitrary (Sticker Possession)	This kid has a smiley face sticker [<i>matching the sticker the child was given prior to the study</i>]. This kid has a rainbow sticker.

Procedure. While a caregiver was filling in a consent form, the experimenter gave the participant a smiley face sticker to place on their hand for use during the study. The experimenter also asked parents to indicate the name their child uses to refer to where they live (e.g., the name of the city), and a TV show or book that the child enjoys from a list provided to them.

To familiarize the participant with the procedure and the different answer options, the experimenter began with a practice trial. The experimenter showed the participant a pair of child faces, and demonstrated that the participant could answer questions by pointing to the child on the left-hand side of the screen, the child on the right-hand side of the screen, or by pointing to both pictures. The participant was asked to repeat each possible response by pointing to the photos as the experimenter had demonstrated, and the experimenter praised the participant when they pointed correctly. The experimenter then provided facts about physical features of the children in the photos and asked the participant to point to the photo that represented each of these traits to encourage this form of responding (e.g., “Who has a triangle badge? Who has hair?”). If the participant did not respond correctly, the experimenter repeated the information about each child and asked again until the participant answered correctly.

The experimenter then presented a new pair of photos and conducted the first similarity manipulation by providing a fact about each of the children in the photos (see Table 1) then conducted a memory check to ensure the participant had registered the fact about each child (e.g., “Do you remember who lives in *City Name*, New Zealand?”). If children failed the memory check, the experimenter repeated the facts about the children in the photos and asked again until children answered correctly. One child failed a memory check after multiple prompts and this block (3 questions) was therefore removed from the analyses. The experimenter then reminded children of the 3 possible answers (the similar child, the dissimilar child, or both) and then asked the three knowledge questions. If participants stated that they did not know, they were told they could guess. If children answered the question themselves (e.g., “I know, grass is green!”), the experimenter reminded them of the response options and repeated the question. Although we had piloted the knowledge items before the study, four participants in the study (or their parents)

indicated that they did not know one of the familiar cultural knowledge items (what ‘poi’ are), and therefore this question was removed from analyses for these children. After the child had answered all three questions, the procedure was then repeated with the second and third pair of photos. Children’s responses were coded online by the experimenter, and 20% of participants were reliability coded offline by a coder blind to the similarity manipulation and the age of the child. The experimenter and the offline coder agreed on 100% of trials.

Results

To first examine whether children’s choices of the similar child differed depending on similarity type within each knowledge type, children’s similar child responses were scored ‘1’ and other responses were scored ‘0’. We followed the analytical procedure of Soley (2019) in order to examine whether participants’ selective predictions of sharing knowledge with the similar child differed across similarity types and knowledge types.

To test our first question of whether children are more likely to use a relevant cue of shared group membership (i.e., location) to predict that someone shares their cultural knowledge, we ran a mixed effects logistic regression with similarity type (location, TV, sticker) as fixed predictor, participant number as random predictor, and choice of the similar child as the outcome variable. The model was significant, Wald $\chi^2 = 6.49$, $df = 2$, $p = .039$ (see figure 1). When asked about familiar cultural knowledge, children’s choices of the similar child were greater when similarity was in location relative to sticker, $Z = 2.40$, $p = .017$, $OR = .30$, 95% CI [.11, .80], and marginally higher for similarity in location relative to TV, $Z = 1.95$, $p = .051$, $OR = .38$, 95% CI [.15, 1.0]. We added age in months as a continuous covariate to the model to assess whether children’s responding changed with an increase in age. Model fit was not significantly improved by adding age, Wald $\chi^2 = 3.48$, $df = 2$, $p = .17$. For planned binomial tests against chance responding within each similarity type, we therefore collapsed across age. Chance responding was .333 with 3 response options.

Children's choices of the child similar in location were significantly greater than chance when judging familiar cultural knowledge (19/33, $p = .005$). Children's choices of the child similar in TV show familiarity (13/38, $p = .86$) and assigned sticker (11/38, $p = .73$) did not differ from chance when judging familiar cultural knowledge (see figure 1).

We ran a mixed effects logistic regression to assess novel cultural knowledge, with similarity type (location, tv, sticker) as fixed predictor, subject as random predictor, and choice of the similar child as the outcome variable. The model was not significant, Wald $\chi^2 = 3.14$, $df = 2$, $p = .208$, suggesting that children do not expect the child similar in location to be simply more likely to possess all cultural knowledge. Model fit was not significantly improved by adding age as a continuous covariate, Wald $\chi^2 = 1.3574$, $df = 2$, $p = .503$. Planned binomial tests explored whether children's choices suggested an expectation that the child from a different location would be more likely to possess novel cultural knowledge. Children's choices of the child different in location were indeed significantly greater than chance when judging novel cultural knowledge (21/37, $p = .004$). Children's choices of the child different in TV show familiarity (16/38, $p = .30$) and assigned sticker (13/38, $p = .86$) did not differ from chance when judging novel cultural knowledge.

Finally, we ran a mixed effects logistic regression assessing general knowledge with similarity type (location, tv, sticker) as fixed predictor, subject as random predictor, and choice of the similar child as the outcome variable. The model was not significant, Wald $\chi^2 = .58$, $df = 2$, $p = .747$, suggesting that children did not broadly expect children similar to themselves to be more likely to share their general knowledge. Model fit was not significantly improved by adding age as a continuous covariate, Wald $\chi^2 = 2.29$, $df = 2$, $p = .318$. Planned binomial tests explored whether children tended to choose "both children" for general knowledge. The rates of choosing "both" were not different from chance in any condition, $ps > .17$.

Figure 1. Proportion of children's choices of each possible response option across similarity types and knowledge questions in Study 1. An asterisk (*) indicates a significant result ($p < .05$): an interaction between similarity type and response, or responding above chance level (0.33, represented by the dotted line).

Discussion

Participants predicted that another child from their own city and country would be more likely to share their cultural knowledge, and that a child from a different location would be more likely to possess novel cultural knowledge. Participants did not use TV show or sticker information to predict cultural knowledge. Importantly, participants did not use any similarity information to predict general knowledge, suggesting that they use cultural group membership information selectively to predict who shares relevant cultural knowledge; that

is, they do not simply think that people from the same place are more likely to share all of their knowledge or to know more in general. These findings also provide evidence that children do not require prior experience with a specific individual in order to predict their knowledge, as children in this study predicted the knowledge of strangers when provided one piece of information about their group membership.

Study 1 provides evidence that young children can already consider which pieces of their *own* cultural knowledge are likely to be shared by others and use relevant cues (but not unrelated cues) to predict shared knowledge. This suggests that although these young children are likely not taught explicitly that cultural knowledge is specific to their city or country, they have some intuition already of the types of knowledge that are more restricted to cultural groups and at least one type (general knowledge) that is not. Children throughout our age range responded consistently when predicting both cultural and general knowledge, suggesting stability in children's knowledge predictions between age 3 and age 6.

One interesting finding showed that children predicted novel cultural knowledge would be known by someone who lived in a different geographic location to participants. Children selectively inferred that only someone with a different geographic location would possess these pieces of cultural knowledge and not someone with a different sticker or familiarity with a different tv show. This highlights that young children may not only be able to predict who shares their own cultural knowledge, but also predict who is likely to share knowledge that children do not have themselves. If children do in fact predict who shares novel knowledge, this will provide compelling evidence that children are using generalisable rules or guides (heuristics) in order to predict the knowledge of others, rather than simply considering observable access to information or prior experience predicting who shares a specific piece of knowledge. Use of a generalisable heuristic to predict knowledge from early in development may also explain why we found no significant differences across our age

range in Study 1, despite the increase in diversity and breadth of social experiences as children get older.

How are children selectively predicting which people share cultural knowledge? Does the development of predicting another person's knowledge happen through children recognizing that specific pieces of knowledge are shared with people in a certain location, and then coming to a more abstract idea of what types of knowledge tend to be culturally shared across groups? If children are using their own experience with knowledge items to scaffold their expectations of how knowledge is shared, we might expect children to have more difficulty with abstract inferences of how different types of knowledge are shared across group members when the knowledge is not familiar to children themselves.

Alternatively, perhaps even young children have a more abstract sense of the categories of knowledge and information that tend to be shared across groups leading them to make selective predictions about which groups of strangers are likely to share which types of knowledge. Study 2 examines these questions, asking whether 3- to 6-year-old children make predictions about the way novel cultural knowledge is shared between third parties who share either a relevant group membership (same location) or an irrelevant one (same age).

Study 2

In Study 2, we compared 3- to 6-year-old's intuitions about which groups of people share cultural knowledge to another type of knowledge typically more limited in scope and not usually predictable by cultural group status—episodic knowledge (e.g., Köymen, Schmerse, Lieven, & Tomasello, 2014; Wyman, Rakoczy, & Tomasello, 2009). Episodic knowledge is more idiosyncratic in nature than cultural knowledge. While children may be able to operate under a general rule that everybody knows general knowledge, episodic knowledge is selectively shared with those that have access to it meaning that children need to consider an individual's access specifically when predicting episodic knowledge. By

studying how children predict which groups of strangers share pieces of novel knowledge, we removed children's personal experience with both the individuals and the knowledge being predicted. In order for children to still predict that cultural knowledge is selectively shared between people who live in the same location, they must be making more abstract inferences about the way that cultural knowledge is typically shared within different social groups. Additionally, if children, as hypothesised, predict that people from the same location are no more likely to share episodic knowledge, this would demonstrate an abstract consideration of the way different pieces of knowledge are typically shared within groups.

Participants were presented with two children, each of whom was similar to a third target child on one dimension. The two dimensions of similarity we contrasted in Study 2 were geographic location information (relevant to predicting cultural knowledge but not episodic knowledge), and age information (not relevant to either type of knowledge). We use age as a comparison to location in this study because children do sometimes make knowledge predictions based on age when it is relevant (Fitneva, 2010), however age should not be a relevant cue for predicting the knowledge items we presented in Study 2. Children were not given specific information about the name of the country which the three children in the photos were from, or their specific ages. This meant that children would not be able to reason using information associated with a specific country or associated with a specific age, and instead would have to consider the category of similarity when making their knowledge predictions.

If children can reason abstractly about the ways that different types of knowledge are typically shared between different kinds of social groups, they should indicate that the cultural knowledge items are more likely shared between children who live in the same country than children who are the same age. This would indicate that children employ a knowledge prediction strategy that generalises to selectively predict who shares novel

cultural knowledge. Children should also be less likely to indicate that episodic knowledge is shared between people from the same country than cultural knowledge since there is no reason to believe that either group member (same age or same country) should have privileged access to person-specific knowledge items (similar to person-specific subjective preferences; Soley & Aldan, 2020; Weatherhead et al., 2018).

Method

We preregistered the sample size and analysis plan for Study 2 on the Open Science Framework (https://osf.io/3dqwf/?view_only=c74118cb24be48b7a2f1c472b99eb572).

Participants. Eighty 3- to 6-year-old children participated in this experiment ($M = 60.32$ months, $SD = 13.71$, range = 38.33 – 83.60 months, 43 females). We collected an equal number of children of each age but as in Study 1, we planned to treat age continuously. All participants were typically developing children who participated in a city in New Zealand. Children either participated in a lab testing room, or in a quiet area at a child play space or at the Zoo. Children needed to understand English to be eligible to participate. Data was collected between February and August 2019. One 3-year-old and one 4-year-old were excluded for not passing memory checks or giving a response to any test question.

Table 2. *Knowledge questions used in Study 2.*

<i>Cultural Knowledge</i>	<i>Item</i>
Language	This kid knows how to say, “Yes please,” in the language called Kovi. Who else would know how to say, “Yes please,” in the language called Kovi?
Places	This kid knows where the museum Miloo is. Who else would know where the museum Miloo is?
Music	This kid knows how to sing the song Genovia. Who else would know how to sing the song Genovia?
Food	This kid knows that the fruit called Zayah is purple. Who else would know that the fruit called Zayah is purple?
<i>Episodic Knowledge</i>	<i>Item</i>
Appearance	This kid’s sister Kovi has brown hair. Who else would know that Kovi has brown hair?
Toy	This kid just named their teddy bear Miloo. Who else would know that this kids’s teddy is named Miloo?
Activity	This kid just wrote the word Genovia in their book. Who else would know that this kid wrote the word Genovia in their book?
Naming	This kid just built a sand castle and called it Zayah. Who else would know that this kid’s Sand Castle is called Zayah?

Stimuli and Design. Each participant was presented with photos from the same CAFE stimulus set used in Study 1 (LoBue, 2014), however, here children were presented with triads of photos instead of pairs. Participants saw one photo at the top of the screen (the target

child), with one child on the left and one child on the right of the bottom of the screen. The children in the photos were gender-matched to the participant.

Study 2 used a 2x2 mixed design. Type of similarity (location vs. age) was presented within-subjects, and knowledge type (cultural vs. episodic) was manipulated between-subjects. On all 4 trials, participants were presented with one child similar to the target in location but not in age, and one child similar to the target in age but not in location. Knowledge type was manipulated between subjects such that each child was either presented with 4 cultural knowledge items consisting of songs (Soley & Aldan, 2020), food (Liberman et al., 2016), language (Kinzler et al., 2007), and places (Study 1, museum knowledge item; e.g., “This kid [target] knows how to sing the song Zayah. Who else would know how to sing the song Zayah?”) or 4 episodic knowledge questions that consisted of individual events, names, and personal relationships that should not be known by strangers (e.g., “This kid [target] has a teddy named Zayah. Who else would know that this kid’s teddy is named Zayah?”; see Table 2 for a list of all knowledge items). The side of the child similar to the target in location and the order of knowledge items was counterbalanced across participants and alternated across trials within participants. The novel words used in the questions were the same in cultural and episodic conditions and were always presented in the same order across trials, such that each novel word was paired with each knowledge item across participants (e.g., sometimes Zayah was a song and sometimes a museum).

Procedure. The procedure was similar to Study 1 with a few key differences. During a practice trial using badges (as in Study 1), participants were taught that they could only respond by pointing to the child on the left-hand side of the screen or the right-hand side of the screen. There was no option to respond ‘both’ in Study 2. Once participants had completed the practice trial, the experimenter introduced three new photos and began the first test trial. The experimenter told the participant that the target child and one of the test

children were from the same geographic location (“These kids [target + left side] live in the same country, but this kid [right side] lives in a different country”), and that the target child and the other test child were the same age (“These kids [target + right side] are the same age, but this kid [left side] is a different age”). The experimenter then conducted a memory check (e.g., “Who lives in the same country as this [target] kid?”). If participants failed the memory check, the experimenter repeated the manipulations and asked again. If a participant failed a memory check after three prompts, that trial was removed from the analyses. After the memory check, the experimenter asked the knowledge test question. The experimenter then presented the second triad and repeated the procedure for the second, third, and fourth trials.

Results

In order to compare children’s responses across knowledge type, we first coded a ‘same location’ response as 1 and a ‘same age’ response as 0. We ran a mixed effects logistic regression with knowledge type as a fixed predictor and participant number as a random predictor to assess whether the number of ‘same location’ responses differed between the cultural knowledge and episodic knowledge conditions. The model demonstrated no significant effect of knowledge type on children’s same location responses (Wald $\chi^2 = .056$, $df = 1$, $p = .814$). To assess whether participant age changed their response pattern, we added age in months as a continuous covariate to assess main effects and interactions with knowledge type. There was also no main effect of participant age (Wald $\chi^2 = .016$, $df = 1$, $p = .899$) or interaction between knowledge type and age (Wald $\chi^2 = .92$, $df = 1$, $p = .338$) so we collapsed across age for subsequent analyses. As planned in our preregistration, we analysed item type in both the cultural knowledge and episodic knowledge conditions to check that children were treating all items as equally likely to be shared between people from the same location. We split the data file by cultural and episodic knowledge as the items differed between conditions and added item type as a fixed factor into the model. This showed no

item differences in the cultural knowledge condition (Wald $\chi^2 = .22$, $df = 3$, $p = .974$) or the episodic knowledge condition (Wald $\chi^2 = 1.4245$, $df = 3$, $p = .698$).

Preregistered analyses were conducted to compare children's same location responses to chance level in each knowledge condition. To account for children who had individual trials excluded (e.g., for failing only one of the memory checks), we calculated a proportion of same location responses for each participant and compared this to chance level (0.5). Children's same location responses were significantly above chance level in both the cultural knowledge condition ($M = .60$, $SD = .23$; $t(39) = 2.65$, $p = .011$, 95% $CI [.52, .67]$; see Figure 2) and the episodic knowledge condition ($M = .59$, $SD = .27$; $t(39) = 2.12$, $p = .041$, 95% $CI [.50, .68]$; see Figure 2).

Discussion

Three- to 6-year-old participants expected novel examples of typically cultural knowledge (songs, language, food, and museums) but also novel examples of episodic knowledge (names, activities) to be shared between people who lived in the same country more so than people who were the same age. As in Study 1, participant age did not affect their knowledge predictions, suggesting a consistency in responses across our age range.

Though we predicted that children would use location is a more informative cue than age when predicting cultural knowledge, we did not predict that children would also use location as a more informative cue to predict episodic knowledge. Children were more likely to choose the person from the same country rather than the person who was the same age, regardless of knowledge type (cultural or episodic). Children's high rates of responding location in both knowledge conditions could indicate that children incorrectly view location as a better cue than age for all types of knowledge, even when location information is irrelevant to consider. As children do not expect preferences to be selectively shared within social groups (those who speak the same language; Soley & Aldan, 2020), perhaps children

view preferences as more idiosyncratic than knowledge generally, leading them to disregard group level information when reasoning about the way preferences are shared, yet overextend the informativeness of cultural group membership information when reasoning about the way that (any kind of) knowledge is shared.

Children may recognize cultural group membership is a good cue of shared cultural knowledge more so than some other kinds of knowledge, but still overextend this cue when making predictions about episodic knowledge in particular. This may be especially true given the necessity to consider a specific partner's knowledge when predicting both cultural and episodic knowledge (in contrast to general knowledge which is typically shared by most people regardless of their specific knowledge set), but the lack of information we provided about access to episodic knowledge in Study 2. This may have caused an episodic knowledge specific error. However, it is also possible that children believe all knowledge is more likely to be shared between people who are from the same place.

Study 3

To separate these possibilities, Study 3 more closely examined whether children make selective inferences about the types of knowledge that are shared between people who share cultural group membership (people from the same place), by asking how 3- to 6-year-old children expect procedural knowledge (e.g., how to tie your shoelaces, how to read) to be shared. One possibility is that children treat age as a more informative cue than location when predicting procedural knowledge, especially given the procedural information we presented is often related to age milestones (e.g., learning to write when you start school at age 5). Importantly, this pattern of results would demonstrate that children do not think that location is *always* a more informative cue to consider when predicting knowledge and that they may have had specific difficulty reasoning about episodic knowledge in Study 2. Conversely, as in Study 2, children may overuse geographic location information to make their knowledge

predictions and respond that children from the same country are more likely to share procedural knowledge. This would indicate a bias towards location information which is relevant to cultural group membership (at least when compared to age information) when making judgements about which groups of strangers will share any type of knowledge.

Method

We preregistered the sample size and analysis plan for Study 3 on the Open Science Framework (https://osf.io/69wuv/?view_only=3e26ed0b3cd34f3eaf5c51cbf56df018).

Participants. Forty 3- to 6-year-olds participated in this study ($M = 60.65$ months, $SD = 12.54$, range = 38.8 to 80.43; 23 female). All participants were typically developing children who participated in a lab testing room, or in a quiet area at a child play space or at the Zoo. Children needed to understand English to be eligible to participate. Data were collected between November and December 2019. Three additional children were run but excluded for refusing to follow instructions and answer test questions ($n = 2$) or parental interference ($n = 1$).

Stimuli and Procedure. The stimuli photos and procedure were identical to Study 2, except that participants were presented with 4 procedural knowledge items (e.g., ‘Who else would know how to read?’; for a list of knowledge items see Table 3 in supplementary materials).

Table 3. *Knowledge questions used in Study 3.*

<i>Procedural Knowledge</i>	<i>Item</i>
	This kid knows how to read. Who else would know how to read?
	This kid knows how to tie their shoelaces. Who else would know how to tie their shoelaces?
	This kid knows how to swim. Who else would know how to swim?
	This kid knows how to write their name. Who else would know how to write their name?

Results

As in Study 2, we first coded a ‘same location’ response as 1 and a ‘same age’ response as 0. We then conducted a mixed effects logistic regression with participant number as a random predictor to assess whether age in months or item type influenced children’s responding. The model demonstrated no main effect of age in months (Wald $\chi^2 = 1.10$, $df = 1$, $p = .295$) or item type (Wald $\chi^2 = 3.99$, $df = 3$, $p = .262$) so we collapsed across age and item for subsequent analyses. Planned analyses compared children’s responding for procedural knowledge items to chance. In order to account for individual trials that were excluded from the analysis, we calculated a proportion of same location responses for each child and compared this proportion to chance level (0.5). Children’s same location responses were significantly below chance ($M = .41$, $SD = .23$; $t(39) = -2.24$, $p = .031$, 95% CI [.34, .49]; see figure 2).

We conducted an exploratory analysis to compare participants’ pattern of responding for procedural knowledge items to the pattern of responding for cultural and episodic

knowledge items in Study 2. We added knowledge type (cultural, episodic, procedural) as a fixed factor into the model with participant as a random factor. The model showed a significant effect of knowledge type (Wald $\chi^2 = 12.35$, $df = 2$, $p = .002$; see figure 2). Children gave significantly more same location responses in the cultural knowledge condition than the procedural knowledge condition ($Z = -3.14$, $SE = .23$, $p = .002$, $OR = 2.06$, 95% $CI [-1.26, -.18]$). Children also gave significantly more same location responses in the episodic knowledge condition than the procedural knowledge condition ($Z = -2.89$, $SE = .23$, $p = .004$, $OR = 1.95$, 95% $CI [-1.21, -.13]$).

Figure 2. Proportion of 'Same Location' responses across Study 2 (Cultural and Episodic Knowledge) and Study 3 (Procedural Knowledge). An asterisk (*) indicates a significant result ($p < .05$) between conditions or above chance level (0.5, represented by the dotted line); error bars represent the standard error of the mean.

Discussion

Study 3 suggests that 3- to 6-year-old children use age as a more informative predictor of procedural knowledge than location. In the context of Study 2, where children judged that people from the same country were more likely to share both cultural and episodic knowledge, Study 3 provides evidence that children do not simply think of location as a more informative cue for knowledge in general. Rather, they appear to overextend the use of location information to episodic knowledge specifically.

General Discussion

Three studies demonstrate selectivity in children's predictions of who shares cultural knowledge. Study 1 demonstrated that children expected someone from the same city and country as themselves to be more likely to share their own cultural knowledge, and someone from a novel city and country to be more likely to have novel cultural knowledge. Children disregarded group membership information when predicting general knowledge. Study 2 provided evidence that 3- to 6-year-old children expect novel cultural knowledge to be more likely shared between people who live in the same place than those who are the same age. However, children also expected personal episodic knowledge to be more likely shared between people from the same location. Study 3 demonstrated children expect procedural knowledge to be more likely shared between people who are the same age than those from the same location, showing that children do not treat all types of knowledge as more likely shared between those in the same location. Combined, these studies demonstrate selective predictions about which kinds of people are likely to share cultural knowledge. The current studies also use different types of knowledge as a contrast (e.g., general knowledge, episodic knowledge, and procedural knowledge) where other papers have focused on preferences (Soley & Aldan, 2020; Weatherhead et al., 2018; c.f., Soley, 2019). Using other types of knowledge as a comparison allows us to assess whether children understand that only their

cultural knowledge (and not their general, episodic, or procedural knowledge) should be shared with other members of the social groups from which that knowledge is associated.

The findings provide consistent evidence that children are able to make accurate predictions about others' cultural knowledge. In Study 1, children differentiated between relevant and irrelevant cues of group membership when predicting who shares their own cultural knowledge and understood that the relevant cue of geographic location is less important to consider when estimating more widely shared general knowledge. These results are striking because children in previous studies *do* use even arbitrary group cues to make evaluations of others' behavior or form attitudes and preferences towards individuals (e.g., Abrams et al., 2015; Patterson, & Bigler, 2006). However, in Study 1 children across age did not expect others who were in the same (but less relevant; sticker and TV show) groups as them to be any more likely to share their cultural knowledge. Study 1 suggests that children have some intuitions about how their cultural knowledge is (and is not) shared at a fairly young age, despite that they are likely not given explicit teaching early on which knowledge is shared by different groups. The items we used in Study 1 are common knowledge among people in the city and country where participants live, so it would be quite reasonable for them to treat these items similar to general knowledge—yet they do not. We do not predict that children always know which pieces of their knowledge are specific to people from their own geographically defined cultural group; most people can think of examples of things they once believed *everyone* knew about, and later discovered were an idiosyncrasy of their own country or town. Rather, we suggest that children are beginning to recognize early on certain broader categories of knowledge which tend to focus on culturally shared phenomena (e.g., cultural institutions like museums, culturally shared behaviours like music and language), and use similarity cues like shared geographic location and community membership to predict how these categories of knowledge, but not others, are shared.

Adding to this evidence from Study 1, Studies 2 and 3 demonstrate that children use abstract information about the people or knowledge in question to predict how it is selectively shared. Children predicted that novel cultural knowledge was typically shared between people from the same place yet predicted that procedural knowledge was more likely to be shared between children of the same age. Importantly, this pattern of predictions required children to make an abstract inference about the type of knowledge and group membership categories in order to predict how novel knowledge is typically shared within groups. These findings provide evidence that 3- to 6-year-old children not only predict who shares their own knowledge but are employing a generalizable knowledge prediction process that results in selective predictions for novel pieces of cultural knowledge.

Contrary to our predictions, participants in Study 2 predicted that children from the same location would be more likely to share episodic knowledge as well as cultural knowledge. This finding suggests that despite children successfully using group cues to predict shared cultural knowledge and behavior in our own and prior work (Goldvicht-Bacon & Diesendruck, 2016; Liebal et al., 2013; Soley & Aldan, 2020; Soley & Spelke, 2016) and predicting episodic knowledge when provided information about knowledge access (Köymen et al., 2016; Wyman et al., 2009), children may struggle to restrict group-based inferences to relevant cultural knowledge only. However, the findings of Study 3 provide evidence that children do not reason that *all* knowledge is more often shared between those in the same location, showing children expected procedural knowledge to be shared by those who were the same age.

Why do children infer that those from the same location are likely to share episodic knowledge, but not procedural or general knowledge? It is possible that children may use different kinds of generalizable information to inform their predictions of general and procedural knowledge than their predictions of cultural and episodic knowledge. Because

general knowledge is typically shared with most people across groups (e.g., most people agree that grass is green), children do not need to consider characteristics about an individual to make a prediction about whether they possess general knowledge. Children may simply operate under the assumption that everyone has general knowledge, leading to a marked non-selectivity in their general knowledge predictions. Procedural knowledge is typically shared by most people as they get older too (e.g., most people will know how to write their name), so children may again operate under the assumption that, while age is important to consider when predicting procedural knowledge, most people will obtain procedural knowledge as they age. This may mean that though children treated age is associated with increases in procedural knowledge generally, they are not viewing procedural knowledge as selectively shared with a group of people in the same way that cultural knowledge typically is. Episodic knowledge is typically only shared with those who have had access to it, again meaning that children need to consider specific characteristics about an individual (i.e., their access to information) to predict who shares episodic knowledge. Because participants in Study 2 were provided with no information about the children's access to the episodic knowledge presented, it is possible that participants instead used other characteristics about the knowledge items (e.g., the fact that one writes in a language they understand, one typically visits places that are near where they live) to guide their episodic knowledge predictions. Understanding how children infer who should and should not share episodic knowledge, especially when provided information about knowledge access, will provide insight into these possibilities.

Though cultural knowledge may also be initially predicted using generalisable rules, predicting who shares cultural knowledge requires children to tailor their predictions to the exact piece of cultural knowledge being predicted and the social groups that a specific piece of information is associated with. Therefore, children cannot operate under the assumption

that most people will share cultural knowledge. How are children making these selective inferences about who shares cultural knowledge? It is possible that at first, children reference specific examples of knowledge or times where others have (or have not) shared their knowledge to make accurate knowledge predictions. As children interact with a wider group of people with unique knowledge sets, such as when children begin attending school, these varied interactions and experience with mismatching knowledge may help them to generalize the way that kinds of knowledge are typically shared, allowing them to extend their predictions to unfamiliar knowledge items and novel groups. The lack of an age effect in any of our studies may hint the idea that individual differences in experience (e.g., contact with various social groups, bilingualism; Fan, Liberman, Kinzler & Keysar, 2015) may be more important than age per se, for developing an understanding of how different types of knowledge are shared between individuals and groups.

Considering, predicting, and integrating a communicative partner's knowledge into ones' inferences and behaviours is important for many of our daily social interactions. Our studies demonstrate that even young children are able to selectively use group membership information to predict cultural knowledge and, further, can discriminate times when using group membership to inform knowledge predictions is not useful. These studies also demonstrate that children are sensitive to different kinds of knowledge and the differential way that information about a partner can be used to inform predictions about those different knowledge types. As they grow and gain new social experiences, children likely develop a more flexible and specific understanding of how individual or group characteristics and knowledge interact, using group membership information to predict how some types of knowledge should be shared.

Chapter 3

Chapter 2 demonstrates that from age 3, young children readily consider and predict who shares their cultural knowledge. Moreover, all children also predicted that strangers from the same location were more likely to share novel cultural knowledge than strangers who were the same age. Because children could not have relied on personal experience with the strangers we asked about or the pieces of knowledge being predicted, this result provides evidence for the use of a knowledge prediction heuristic that allows children to make quick and generalisable predictions about who is likely to share pieces of cultural knowledge (Nickerson, 1999; Royzman et al., 2003; Tversky & Kahneman, 1974). I predict that this heuristic functions through considering how the type of knowledge being predicted is typically shared and then taking information about the individual whose knowledge is being predicted in order to make a quick prediction about whether this individual is likely to possess this specific piece of knowledge.

By virtue of a heuristic being a shortcut, use of this knowledge prediction heuristic may lead to errors if a person's knowledge set or the knowledge item being predicted are not 'typical'. There is evidence which suggests that both children (e.g., Birch & Bloom, 2003; Haddock, 2016) and even adults (e.g., Birch & Bloom, 2004; Fischhoff, 1975; Hinds, 1999) overattribute *episodic* knowledge to others who should not have it in interpretable ways. This is particularly true if they are predicting knowledge that they have themselves, termed the 'Curse of Knowledge' throughout the literature (Birch & Bloom, 2003, 2004). If we possess a piece of knowledge, we are likely to overestimate how probable it is that others also have this knowledge. For example, experts in a field regularly overestimate how much of their expertise a novice shares (Hinds, 1999), adults who know the solution to a problem will overestimate how easily solvable the problem is (Fischhoff, 1975; Kelley & Jacoby, 1996), and that those close to them will understand their ambiguous sentences better than any

partner actually can (Savitsky et al., 2011). There are plenty of examples of children overestimating which pieces of their own knowledge are shared with others too. 4-year-olds report that a similar child in another place will know novel fact participants have just learned (Taylor et al., 1994), 4-year-olds expect ignorant people who simply point at a location to have knowledge of what is there (Palmquist & Jaswal, 2012), and children under 4-years-old readily assume that someone will know the location of an item that was moved in their absence (Wellman et al., 2001; Wimmer & Perner, 1983).

While some of this previous research has highlighted how we may overattribute episodic information to others who should not have it (e.g., Birch & Bloom, 2004; Kelley & Jacoby, 1996; Palmquist & Jaswal, 2012), it is possible that we may find the same type of overestimations for cultural knowledge when this heuristic predicts that a person with specific characteristics should have a piece of knowledge when in fact, they do not. Anecdotally, it is not uncommon for someone to realise in adulthood that something they had assumed was known globally was in fact a country-specific term or item (for me, this includes realising that the word ‘Jovi’ only refers to crayons in New Zealand) or to assume that someone should have a piece of cultural knowledge, even when you have information that may suggest otherwise (e.g., asking a friend who has recently moved to New Zealand to ‘Bring a Plate’ to a dinner party). If we do make these predictable overestimation errors when attributing cultural knowledge to others, it will provide compelling evidence for the use of a knowledge prediction heuristic due to these predictions reflecting the way the heuristic I propose would typically predict knowledge to be shared.

4-Year-Olds (But Not 6-Year-Olds) Overestimate Who Shares

Novel Cultural Knowledge.

Abstract

Though adults can make educated guesses about the things that other people are likely to know, we still occasionally make errors when predicting knowledge. Young children seem especially prone to overestimating who shares their knowledge, yet also appear to readily consider and predict knowledge accurately in other contexts. The current studies investigate whether the type of knowledge being predicted affects how likely children are to overestimate who shares it. In Study 1, 4- and 6-year-olds created two pictures; one picture of well-known person or story, and one picture of a person or story participants invented during the study. Knowledge of people is episodic and not typically shared with strangers, but stories are typically widely shared within people from the same social groups (cultural knowledge). If children predict that cultural knowledge items are widely shared by social group members (but not episodic knowledge), this may cause children to overestimate who should know their novel cultural item. 4-year-olds and 6-year-olds predicted that a child who was not present would know their well-known person but would not know their novel person. However, 4-year-olds (but not 6-year-olds) predicted that a child who was not present was equally likely to know about their well-known story and their novel story. Study 2 replicates this finding with another cultural knowledge item (foods), finding that 4-year-olds (but not 6-year-olds) expect a child who was not present to know both a well-known dish and a dish that participants had just created. Taken together, these findings provide evidence that children have intuitions about the kinds of items that are cultural knowledge and appear to use a knowledge prediction heuristic that assumes cultural knowledge items are widely shared among social group members, causing knowledge overestimations in this context.

Keywords: cultural knowledge, knowledge overestimation, heuristics

Many of our daily interactions require us to predict others' knowledge. Simply communicating with others requires us to consider what someone else will understand, as conveying a message requires that both parties understand the message and the words used to explain it. It is then logical that both adults (Clark & Brennan, 1991; Isaacs & Clark, 1987) and children (Aguiar et al., 2012; Goldvicht-Bacon & Diesendruck, 2016; Miller et al., 2003) are capable of predicting others' knowledge. Nevertheless, our knowledge predictions are not always accurate, and we intermittently overestimate how much of our knowledge is shared with others. Most people will have encountered a situation where you assumed someone had knowledge that they did not. Perhaps a close friend had not seen a movie that you consider a classic, or a colleague from a different country had not heard of your favourite dish. When we usually encounter people who do share a specific piece of knowledge with us, it can make it challenging to accurately predict who does not share that knowledge.

It seems that we are especially prone to overestimating others' knowledge if it is knowledge that we possess ourselves, sometimes termed the 'Curse of Knowledge' (Birch & Bloom, 2003, 2004). For example, experts in a field regularly overestimate how much of their expertise a novice shares (Hinds, 1999), adults who know the solution to a problem will overestimate how easily solvable the problem is (Fischhoff, 1975; Kelley & Jacoby, 1996), and adults predict that their romantic partner will understand an ambiguous statement better than their partner actually can (Savitsky et al., 2011). Young children are also affected by the Curse of Knowledge, and it appears that children make this error even when they are aware that another person has not had access to a particular piece of information. Three-year-olds predict that someone else will know something only the 3-year-old had heard (Mossler et al., 1976), 4-year-olds attribute knowledge of a novel fact that they had just learned to a similar child who was not present when the fact was taught (Taylor et al., 1994), and children up to 6-years-old predict that seeing an ambiguous section of a picture is enough for someone else

to share their knowledge of the whole picture (Carpendale & Chandler, 1996; Taylor, 1988).

If predicting knowledge accurately is so important throughout daily life, why do both adults and children so regularly overestimate how much of their own knowledge is shared with others?

It is possible that this overestimation of others' knowledge might stem from the process we use to help us predict knowledge efficiently. It is important that we predict knowledge accurately but it is also important that we predict knowledge efficiently, because we are often required to predict knowledge while we are communicating with others. Using a heuristic (or mental shortcut) to predict knowledge would reduce the cognitive cost, allowing us to predict knowledge quickly (Royzman et al., 2003; Tversky & Kahneman, 1974). Some researchers have previously theorised that we may use heuristics in order to facilitate efficient knowledge predictions (e.g., Harris, 1992; Keysar et al., 1998; Nickerson, 1999; Royzman et al., 2003). For example, we may simulate what we would predict ourselves to know in someone else's shoes (Harris, 1992) or attribute all of our own knowledge to others and then 'adjust' our predictions using information about the type of knowledge and individual whose knowledge you are predicting (Nickerson, 1999).

Though using a heuristic may facilitate efficient knowledge predictions, not all knowledge could be predicted by considering the same kinds of information. Episodic knowledge consists of knowledge of specific events and experiences, and requires direct (via perceptual access; (Köymen et al., 2016; Pillow, 1989; Pillow & Weed, 1997; Taylor et al., 1994) or indirect access (via being told by a reliable source; e.g., Koenig et al., 2015; Lockhart et al., 2016) to an event in order to 'know' it. For example, 3-year-olds understand that someone cannot know the rules of a novel game if they were not present when the rules were taught (Wyman et al., 2009). Conversely, cultural knowledge consists of knowledge that is typically widely shared among a specific social group or community, meaning that we

can share cultural knowledge with strangers if they are in the same social groups as ourselves (Clark, 1996; Isaacs & Clark, 1987). To predict cultural knowledge, a heuristic would not need to consider knowledge access, but instead group membership and associated cultural knowledge items. Because knowledge predictions need to differ depending on the type of knowledge being predicted and the person whose knowledge you are predicting, any knowledge prediction heuristic must consider these factors in order to generate efficient predictions that are still accurate most of the time.

There is evidence that even young children consider how characteristics of an individual might relate to their knowledge state. For example, young children consult an expert about information within their expertise (e.g., children will ask a doctor about a medical question and trust the testimony of a bird expert when asked a question about birds; Aguiar et al., 2012; Kushnir et al., 2013) and children expect age to be associated with knowledge, with 5- and 6-year-olds predicting that adults and children are likely to possess different pieces of knowledge (e.g., adults will know how to bake cookies, children will know how to jump rope; Fitneva, 2010). There is also evidence that children consider whether an individual has had access to knowledge in order to predict whether an individual knows something or not. Three-year-olds only expect those who were present when the rules of a game were explained to adhere to them (Wyman et al., 2009), and when only some three-year-olds were taught about the needs of a novel animal, these three-year-olds would provide more explanation when discussing animal care decisions with a naïve peer who was not present to learn about this animal's needs than a peer who was present (Köymen et al., 2016). These studies provide evidence that even young children consider some kinds of information about the individual whose knowledge is being predicted in order to adjust their knowledge predictions.

Further, there is evidence that young children have intuitions about the ways that different kinds of knowledge are typically shared. When considering episodic knowledge, young children consider an individual's access to an event (Koenig et al., 2015; Köymen et al., 2016; Lockhart et al., 2016; Mahr et al., 2020; Wyman et al., 2009). Children seem to have early intuitions about the kinds of information that are typically shared within social groups or communities. For instance, infants and young children expect foods preferences to be shared by people who speak the same language (but not different languages) and use social group membership to guide their own food selections (Lieberman et al., 2016; Shutts et al., 2009, 2013). 5- to 6-year-old children, like adults, expect song knowledge to be shared by speakers of the same language (Soley & Aldan, 2020) and some researchers suggest that children view stories as a cultural knowledge item due to their importance in cultural transmission (Király et al., 2017; Tsosie, 2002). The research presented in Chapter 2 supports this idea further, as children selectively predicted that people from the same location would share knowledge of cultural items, including knowledge of landmarks, foods, local language, and songs. Thus, it seems that children have intuitions about the kinds of things that are typically known by social group memberships and use these intuitions to make predictions about who possesses cultural knowledge.

Because of the differences in cultural and episodic knowledge, it is plausible that the heuristic children use to predict others' knowledge may operate differently when predicting episodic knowledge and cultural knowledge. When predicting episodic knowledge, children can predict who shares knowledge by simply recalling a specific person's presence or absence when a piece of knowledge was presented or discussed. Predicting cultural knowledge presents a different inferential challenge, as cultural knowledge can be shared between complete strangers if they share a particular social group membership, meaning that children cannot consider an individual's presence or absence to predict their cultural

knowledge. For example, two strangers who live in the same city may share knowledge of the local language (e.g., native language or slang terms), songs (e.g., the national anthem), landmarks (e.g., museums, parliamentary buildings), or traditional stories (e.g., local myths or legends). This means that children need to understand which kinds of knowledge items are examples of cultural knowledge, that cultural knowledge is selectively shared within social groups, and then make inferences about who is likely to have specific pieces of cultural knowledge based on group membership.

This difference in how children predict episodic and cultural knowledge may also cause a difference in how likely children are to overestimate who shares their episodic and cultural knowledge. If children use a knowledge prediction heuristic which considers the type of knowledge being predicted, when predicting shared knowledge of any cultural item (i.e., a song, food, language, story) this heuristic should predict cultural items to be widely shared among the social groups and communities they are associated with. This is a functional heuristic that would lead to mostly accurate cultural knowledge predictions. However, this efficient heuristic may also lead children to overestimate who shares knowledge of cultural items if a specific example of a cultural item should not be widely shared among a specific social group or community. For example, if children consider knowledge of songs (e.g., the song ‘Tūtira Mai Ngā Iwi’) to be cultural knowledge and expect cultural knowledge to be widely shared by members of a specific social group (e.g., New Zealanders), a heuristic which adjusts knowledge predictions on the type of knowledge being predicted may cause children to attribute knowledge of this cultural item to someone who should really not have it (i.e., a child who has only just moved to New Zealand). That is, a knowledge prediction heuristic would initially predict that cultural knowledge items are widely shared within a social group or community (because that is the way that cultural knowledge is typically shared), even if knowledge of this particular example should not be shared. Children should

be less likely to make this same overestimation error when predicting episodic knowledge (i.e., attributing knowledge of an episodic item to someone who may not have had access to it) because the information needed to predict episodic knowledge is different (information about who was present or absent when a piece of knowledge was presented or discussed). However, if children do not form intuitions about the kinds of knowledge items that constitute cultural knowledge or if children do not expect knowledge of all cultural items to be shared between social group members, children may instead rely on knowledge access to predict knowledge of both the episodic and cultural items.

Study 1

The current studies examine how 4- and 6-year-old children predict their knowledge is shared with others. Specifically, we are interested in whether children are more likely to overestimate who shares knowledge of an item, if the item is an example of cultural knowledge rather than episodic knowledge. Because previous literature examining knowledge overestimations has studied children between 3- and 6-years (Carpendale & Chandler, 1996; Mossler et al., 1976; Taylor, 1988; Taylor et al., 1994) and demonstrates some reduction in knowledge overestimations as children age (Birch & Bloom, 2003, 2004), we decided to test 4-year-olds and 6-year-olds to examine how cultural knowledge overestimations may change throughout early childhood. We predict that these intuitions will mean children are more likely to overestimate who shares knowledge of a novel item if this item is an example of typically cultural knowledge rather than typically episodic knowledge.

Participants in Study 1 were asked to create two pictures of an item; one was an example of a cultural knowledge item which strangers within a cultural group would typically share knowledge of (stories; see Király et al., 2017; Soley & Spelke, 2016; Tsosie, 2002) and one was an example of an episodic knowledge item which strangers within a cultural group would not typically share knowledge of (who specific people are; see Clark et al., 1983;

Liebal et al., 2013). Participants were asked to create a picture of both a well-known and novel version of their item (story or person). The well-known versions were selected because they are broadly known by children throughout New Zealand (Elsa from Frozen, Buck & Lee, 2013; The Gruffalo, Donaldson, 1999) and children invented the novel versions themselves during the study using novel stimuli. After creating each item, participants were asked whether another child, who had not been present while participants created their pictures, would know who (person) or what (story) their picture was of. We asked children to create both a novel and a well-known cultural knowledge item in order to understand how children predict cultural items are shared when an item should be shared in a typical way (i.e., when a cultural knowledge item should be shared with someone from the same social group or community). We asked participants to create both a well-known and novel episodic knowledge item to understand whether children think all kinds of typically episodic knowledge items rely on direct access or whether children predict that a child who was not present could still know about a well-known example of a typically episodic item. As only the participant and the experimenter (and occasionally a caregiver) were present during the study, no one except for those individuals could know the novel item participants had just created. However, we predict that because stories are an example of a cultural knowledge item, children may overestimate who shares knowledge of the story children had just invented because cultural knowledge items are typically shared by other members of a social group or community. Conversely, episodic knowledge items should be predicted using information about knowledge access, meaning that children should not be as likely to overestimate who shares knowledge of the novel episodic item participants had just invented.

First, we predicted that participants would attribute knowledge of the well-known item to this new child more often than the novel version. Because previous research has demonstrated that by age 4, children understand that someone cannot know something they

have not had access to (e.g., Köymen et al., 2016; Wyman et al., 2009), we expect participants to predict that someone who had not been present when they created their novel item would not know it. Additionally, because children can accurately predict which strangers share some kinds of well-known knowledge (e.g., cultural figures or songs; Liebal et al., 2013; Soley & Aldan, 2020), we expect participants to predict this new child shares their knowledge of the well-known person or story, even though participants did not observe this child having access to it. Importantly, we predict a condition difference between children's predictions for their novel episodic knowledge item (people) and novel cultural knowledge item (stories). If the heuristic that children use to knowledge predictions takes information about the way different types of knowledge (i.e., episodic, cultural) are typically shared with others and forms intuitions about the kinds of knowledge items that make up these types of knowledge, such a heuristic should lead participants to estimate that a new child will share their knowledge of something which is typically known by other children (cultural knowledge of stories) but not something which is typically more person-specific (episodic knowledge of people). Thus, we predict that participants will be more likely to overestimate shared knowledge of their novel story than knowledge of their novel person.

Method

Participants

Forty-two 4-year-olds ($M=53.10$ months, $SD=3.62$, $range=48.20-59.80$; 24 females) and forty-two 6-year-olds ($M=77.65$ months, $SD=3.53$, $range=72.83-84.0$; 24 females) participated in the current study. Participants were typically developing children from a mid-size city in New Zealand. To be eligible to participate, children needed to know of Elsa from the movie 'Frozen' (Buck & Lee, 2013) or the story 'The Gruffalo' (Donaldson, 1999). Data was collected between November 2019 and January 2021. Four participants were excluded from the final analyses due to choosing to stop the study part way through ($n=1$), not answering a test question ($n=1$), or experimenter error ($n=2$).

Stimuli and Design

Participants were either presented with picture pieces which could be stuck together to construct a person or picture pieces that could be stuck together to construct a story (see Figure 3). Of these pieces, 3 of the character pieces could be stuck together to create Elsa and Olaf (Buck & Lee, 2013), and 3 of the story pieces could be stuck together to outline the story of *The Gruffalo* (Donaldson, 1999). The remaining pieces consisted of story pictures that were created in our lab and novel character pictures, therefore all other pieces were novel to children prior to participating. Children could pick 3 of these 12 novel pieces to create a novel person or a novel story. Participants were given 4 different picture pieces at a time and were asked to select the piece specific to the picture they were creating (i.e., “*Can you pick Elsa’s head?*”; “*Can you pick what happens first in your new story?*”). Participants were presented with a laminated sheet of paper and blue tack in order to construct their person or story. Study 1 used a mixed design with children participating in either the person or the story condition, but each child created both a well-known and a novel picture. The order of the well-known and novel pictures and the knowledge questions were fully counterbalanced across participants.

Figure 3. Examples of the pictures created by participants, including the well-known person (Study 1), story (Study 1), and dish (Study 2; top row) and the novel person (Study 1), story (Study 1), and dish (Study 2; bottom row).

Procedure

While completing the consent paperwork, parents were asked whether their child know who Elsa from ‘Frozen’ was, or the story of ‘The Gruffalo’ to confirm they were eligible to participate. Upon confirmation, children followed a researcher into a separate research space to complete the study. Participants sat at a child-sized table with the researcher who told children that they were going to be making some pictures by sticking picture pieces

together on a laminated sheet of paper. Children participated in both the well-known and novel item trials, and the experimenter asked the child a test question at the end of each trial. The order of the well-known and novel item trials was counterbalanced across participants.

During the well-known item trial, participants were told that they were going to start by making a picture of a person or story that they know and had seen or read before. The researcher then suggested that the participants make a picture of Elsa (person condition) or The Gruffalo (story condition). When children agreed, the researcher pulled 4 picture pieces out from behind the table and laid them on top of the table. In the character condition, these pieces included 3 novel heads and Elsa's head. In the story condition, these pieces included 3 novel story scenes and the first scene from The Gruffalo. The researcher asked children to select "Elsa's head" or "what happens first in The Gruffalo" and stick it onto the laminated sheet. If children selected an incorrect piece (i.e., one of the novel pieces), they were reminded that they were making a picture of Elsa / The Gruffalo first and the researcher repeated their instruction. This was to ensure that all children were both aware of the well-known knowledge item themselves and created the well-known item as another person would recognise it. In the Story condition, children were also asked to describe what was happening in that scene of the story to ensure they were considering the story line and not simply recognizing the illustrations. Once children had selected the first pieces, the researcher removed the remaining pieces and repeated this process for the following two sets (i.e., choosing a body and "the thing that goes with Elsa" in the character condition, and the middle scene and the end scene in the story condition). The researcher then praised children for making a great picture and pinned their picture up on the wall.

During the novel item trial, participants were told that they were going to start by making a picture of a brand-new person or story that they had never seen before. In the person condition, children were asked to create a 'funny name' for their brand-new person.

This was done to ensure that children did not try to recreate a person who exists already. If children presented a name that was not novel (e.g., ‘Bella’, ‘Superman’), they were told that their suggestion is already a name and were asked to pick a funny name (examples of child coined funny names include ‘Gooberlaney’ and ‘Tuffy’). If children could not think of a funny name after two prompts, the researcher presented two options for funny names (e.g., ‘Kovi’ or ‘Miloo’) and children picked a name for their person. In the Story condition, children were not asked to name their story, because during piloting children often created names which alluded to things that were not present in the story scenes available (e.g., ‘Sam’s Picnic’ yet there were no scenes depicting a picnic). Instead, children were instructed to describe what was happening in each scene of the story as they placed it onto the laminated sheet to create a consistent storyline. As in the well-known item condition, the experimenter then presented 4 picture pieces and asked children to select one (“Can you pick [funny name]’s head?; Can you pick what happens first in your brand-new story?”). This was repeated for the second and third picture pieces. Once children were finished creating their picture, the researcher praised the child for making a great picture and pinned the picture up on the wall.

At the end of the first item trial (either well-known or novel), the researcher then told participants that she was going to ask them questions and that they could respond to these questions by answering ‘Yes’, ‘No’, or ‘Maybe’. We allowed children to respond ‘Maybe’ because we wanted a measure of how sure participants were that a new child would know their knowledge item. The researcher told participants that there was another child named Sam in a different room and that Sam was the same age as the participant. While pointing at the picture the participant created on the wall, the researcher then asked, “If Sam came into this room, would they know who this is (person condition) / this story (story condition)?” Once children had responded to the first test question, children were told that they were going

to make the other version of their person or story (i.e., the well-known story if they had completed the novel story first and vice versa). To avoid children's response to the first test question influencing their subsequent responses, when the test question was repeated for participants' second picture, participants were asked about a different child called Alex.

Once participants had answered both test questions, they were asked two further knowledge questions; whether Alex would know the alphabet and whether Alex would know the colour of the participant's bedroom ("Would Alex know their ABCs?"; "Would Alex know what colour your bedroom is?"). Because we predicted that children would be more likely to overestimate who shares their cultural knowledge (typically widely shared knowledge) but not their episodic knowledge (typically narrowly shared knowledge), we included these two final knowledge questions that ask about a general knowledge item (the alphabet) and a personal knowledge item (bedroom colour) that should be shared with this new child in a way that is typical for those pieces of knowledge. Thus, these questions investigated whether children reason that a new child would typically be more likely to have general knowledge than personal knowledge.

Results

We began by ranking children's responses to each question, with 'Yes' responses ranked 3, 'Maybe' responses ranked 2, and 'No' responses ranked 1 in order to create a 3-point ranking on how sure participants were that this new child did or did not know something. Because we ran two age groups (4-year-olds and 6-year-olds), we ran Mann Whitney U tests to assess whether there were any age differences in responding to the test questions. This analysis demonstrated a significant difference in responding between age groups for the novel test item in both the character ($Z=-2.107, p=.035$) and the story conditions ($Z=-3.014, p=.003$), but no significant difference in responding for the well-known

test item (both $p > .29$). Because we compare responses to the well-known and novel test item within-subjects, we therefore split the subsequent analyses by age group.

We first compared participants' responses to the two test questions in the person condition. A Wilcoxon signed ranks test indicated a significant difference in responding between test items for both 4-year-olds ($Z = -1.96, p = .050$) and 6-year-olds ($Z = -3.36, p = .001$; see figure 4). All children rated Sam/Alex as significantly more likely to know the well-known person (Elsa; 4-year-olds, $M = 2.24, SD = .94$; 6-year-olds, $M = 2.19, SD = .75$) than the person they had just created (4-year-olds, $M = 1.71, SD = .96$; 6-year-olds, $M = 1.19, SD = .60$). However, a Wilcoxon signed ranks test comparing children's responses to the story items demonstrated that 6-year-olds rated Sam/Alex as significantly more likely to know the well-known story ($M = 2.29, SD = .72$) than the story they'd just created ($M = 1.24, SD = .44; Z = -3.64, p < .001$) but 4-year-olds rated Sam/Alex as equally likely to know about the well-known story ($M = 2.05, SD = .74$) and their brand-new story ($M = 1.90, SD = .77; Z = -1.13, p = .257$).

We then analyzed children's responses to the final two knowledge questions. Condition (person, story) had no effect on 4-year-olds' or 6-year-olds' responses to the knowledge questions (all $p > .27$), so we collapse across item for the following analyses. When comparing how likely Sam/Alex was to know the alphabet and the colour of the participant's bedroom, both 4-year-olds ($Z = -3.054, p = .002$) and 6-year-olds ($Z = -5.752, p < .001$) expected Sam/Alex to be significantly more likely to know the alphabet (4-year-olds, $M = 2.26, SD = .89$; 6-year-olds, $M = 2.71, SD = .51$) than the colour of their bedroom (4-year-olds, $M = 1.57, SD = .80$; 6-year-olds, $M = 1.12, SD = .40$).

Discussion

The results of Study 1 demonstrate an age group difference between the 4-year-olds and the 6-year-olds in our sample. 6-year-olds predicted that another child would be more

likely to know about a well-known person and a well-known story than a person or story participants had just created. However, while 4-year-olds thought that another child was more likely to know about a well-known person than a person they had just made up, 4-year-olds thought another child would be equally likely to know about a well-known story or a novel story. Importantly, this finding was due to 4-year-olds overestimating how likely a new child was to know their novel story, rather than estimating that this new child did not know the well-known story (see Figure 4), as children responded that there was some likelihood that a child who was not present could know both a well-known and their novel story. Both 4-year-olds and 6-year-olds reasoned that this new child was more likely to know the alphabet than the colour of the participants' own bedroom, showing that participants (even 4-year-olds) expect a child who was not present to be more likely to know a piece of general knowledge than a piece of personal knowledge.

The difference observed between age groups is consistent with our prediction that knowledge overestimations should decrease with age, and reflects the trends seen in other previous literature. Four-year-olds have been shown to occasionally make counterintuitive predictions about others' knowledge. For example, 4-year-olds predict that a similar child who was not present would know a novel fact that the 4-year-olds had just learned but 6-year-olds do not (Taylor et al., 1994), and this kind of knowledge overestimation appears to decrease with age (Birch & Bloom, 2003, 2004). Understanding that knowledge of people is episodic may have facilitated 4-year-olds predictions that a new child could not know their novel person, as even 3-year-olds seem to restrict their episodic knowledge predictions when someone does not have access to a piece of information (Köymen et al., 2016; Wyman et al., 2009). The 6-year-olds in our study did not make this overestimation error when predicting who would know their novel story. It is plausible that with the extended social experience 6-year-olds have encountering those who do not share pieces of their knowledge (e.g., through

entering school) and increases in inhibitory control between 4- and 6-years (Diamond & Taylor, 1996; Frye et al., 1995; Macdonald et al., 2014) allowing 6-year-olds to inhibit an initial knowledge overestimation, 6-year-olds may be better able to adjust their knowledge predictions more restrictively. That is, 6-year-olds may inhibit the initial prediction generated by a heuristic which suggests that cultural items are widely shared to understand that another child cannot know a story (cultural item) they have just created.

Four-year-olds' overestimation of cultural knowledge is in line with our hypothesis, namely that participants will be more likely to overattribute knowledge to another person if the type of knowledge they are predicting is typically shared (i.e., cultural knowledge). While knowledge of people is typically episodic (often you do not know a person until you have met them), knowledge of stories is something which is shared more broadly, often between people from the same social or cultural groups. We predicted that children would use a heuristic to predict knowledge which considers both characteristics of their communicative partner and the type of knowledge being predicted (Harris, 1992; Nickerson, 1999; Royzman et al., 2003). We predicted that this heuristic may cause children to struggle when adjusting their cultural knowledge predictions more than their episodic knowledge predictions. Children predicted someone else's knowledge of a novel item that was an example of a thing that would typically be cultural knowledge. Because cultural items tend to be widely shared among the social groups they are associated with (e.g., people from the same location), use of a knowledge prediction heuristic may have caused 4-year-olds to overestimate who was likely to share knowledge of their novel cultural item.

Study 1 highlights that predicting cultural knowledge may be one cause of young children overestimating who shares their knowledge. We propose that in Study 1, 4-year-olds overattributed knowledge of their novel story to a new child because stories come from a category of knowledge which is typically widely shared, cultural knowledge. We predict that

because many people (and even strangers) will often share a child's knowledge of a story, it is more challenging for children to restrict their knowledge predictions for stories than for people, even when someone should not know a particular story being discussed. Knowledge of people is not typically shared in the same way, as knowledge of a person often requires you to have direct access to them (e.g., through meeting them). Young children may have experienced someone else knowing a person whom the child themselves did not know or vice versa (e.g., a parent having a friend over which the child had not met before, a child telling their parent about a friend they met at kindergarten). This may not be true for stories given the widely shared nature of story knowledge within social groups.

While we predict that 4-year-olds overattributed knowledge of their novel story due to stories being an example of cultural knowledge, it is possible that 4-year-olds predicted a new child would know their novel story for another reason. In the person condition, we asked children to name their novel character. However, in the story condition, we instead asked children to tell the story as they were putting the scenes together. Therefore, it is possible that the act of naming something facilitates children's reasoning about who else should know that thing. There is some evidence in support of this idea, with one paper showing that 4-year-olds restrict their knowledge predictions more appropriately when predicting something with a proper name (i.e., a person's name; Taylor et al., 1994). Additionally, while we predict that 4-year-olds overestimating who shares knowledge of their novel story is due to stories being an example of cultural knowledge, this could be a story specific error. That is, it is possible that 4-year-olds overestimated how stories are shared specifically, rather than overestimating how stories and also other novel cultural items are shared.

Study 2

Study 2 aims to replicate the cultural knowledge condition with a different cultural knowledge item. If 4-year-olds are overestimating who shares knowledge of a novel story

because stories are an example of a cultural knowledge item, we should see 4-year-olds making this same overestimation error with other examples of cultural items. However, if 4-year-olds are overattributing knowledge of stories for another reason specific to stories, we should not replicate this overestimation error with another cultural item. We selected another example of cultural knowledge, food, as previous literature suggests that infants and young children view information about foods as being typically shared within social groups (Liberman et al., 2016; Shutts et al., 2009, 2013). Importantly, children in Study 2 were asked to name their novel dish. If children in Study 1 were overattributing knowledge of their novel story because stories are an example of cultural knowledge which is typically shared with others, we predict that 4-year-olds will overattribute knowledge of their novel dish too, predicting that another child will be equally likely to know the well-known dish and the novel dish. However, if the act of providing a proper name for something facilitates 4-year-olds' understanding of who else should know about that thing or if 4-year-olds made a story-specific error in Study 1, 4-year-olds should predict that a new child is more likely to know about the well-known dish than their novel dish. If 6-year-olds are better able to adjust the initial knowledge prediction generated by the heuristic I have proposed (as in Study 1), 6-year-olds should expect a new child to be more likely to know their well-known dish than their novel dish.

Method

Participants

Forty-two children participated in Study 2; twenty-one 4-year-olds ($M=52.94$ months, $SD=3.56$, $range=48.3-58.93$; 13 females) and twenty-one 6-year-olds ($M=78.88$ months, $SD=3.28$, $range=72.73-83.93$; 12 females). Participants were typically developing children from a mid-size city in New Zealand who had not participated in Study 1. Data was collected

between July 2020 and January 2021. Four participants were excluded from the final analyses due to not providing a clear answer to the test questions ($n=2$) or experimenter error ($n=2$).

Stimuli and Design

The stimuli and design were very similar to Study 1, except that participants were presented with food pieces to create a well-known dish (pizza) and a brand-new dish. When creating a pizza, children were presented with 4 pizza bases to choose from, 4 typical pizza toppings to choose from (e.g., pepperoni, tomato), and 4 cheeses to choose from. When creating a novel dish, children were presented with 4 foods they could choose for a base (e.g., quinoa, konjac noodles), 4 toppings (e.g., pomegranate kernels, rainbow candy), and 4 garnishes (e.g., tamarind paste, banana slices). The foods to create the novel dish were selected because they were uncommon to children in New Zealand or foods that would not typically go together in a known dish. All children created both a well-known and novel dish during the study.

Procedure

The procedure was identical to Study 1, except that participants were told that they would be making pictures of foods. Importantly, children were asked to name their novel dish a ‘funny name’, as in the person condition of Study 1. Children were asked the same test questions and knowledge questions as in Study 1. One participant did not answer one of the knowledge questions, but their data was included as they had answered both of the test questions.

Results

As in Study 1, we ranked children’s responses to each question with ‘Yes’ responses ranked 3, ‘Maybe’ responses ranked 2, and ‘No’ responses ranked 1. We then ran a Mann Whitney U test to assess whether there were any age group differences in responses to the test questions. This showed a significant difference in responding for the novel test item

between 4- and 6-year-olds ($Z = -3.26, p < .001$) and no significant difference for the well-known test item ($Z = -.339, p = .735$). Because we compare responses to the well-known and novel test item within-subjects, we therefore split the subsequent analyses by age group.

We began by comparing children's responses to the two test questions. A Wilcoxon signed ranks test indicated that while 6-year-olds rated Sam/Alex as significantly more likely to know the well-known food ($M = 2.38, SD = .87$) than their brand-new food ($M = 1.33, SD = .66; Z = -3.31, p = .001$), 4-year-olds did not ($Z = -.71, p = .48$; see figure 4). 4-year-olds thought Sam/Alex would be equally likely to know their well-known food ($M = 2.33, SD = .80$) and their brand-new food ($M = 2.24, SD = .89$). Finally, we analyzed children's responses to the knowledge questions. 6-year-olds thought that Alex was significantly more likely to know the alphabet ($M = 2.57, SD = .68$) than the colour of the participant's bedroom ($M = 1.05, SD = .22; Z = -3.99, p < .001$). However, unlike Study 1, 4-year-olds did not respond that Alex was significantly more likely to know the alphabet ($M = 2.20, SD = 1.0$) than the colour of the participant's bedroom ($M = 1.95, SD = .97; Z = -1.3, p = .194$).

Table 4. *Number of 4- and 6-year-old children's 'Yes', 'Maybe', and 'No' responses in the Person and Story conditions (Study 1) and the Food condition (Study 2).*

		Item					
		Person		Story		Food	
		Well-known	Novel	Well-known	Novel	Well-known	Novel
4-year-olds	Yes	12	7	6	7	11	11
	Maybe	2	1	10	9	6	4
	No	7	13	5	5	4	6
6-year-olds	Yes	8	2	9	0	13	2
	Maybe	9	0	9	5	3	3
	No	4	19	3	16	5	16

Figure 4. Children's ranked responses to the well-known and novel test questions across Study 1 (Person, Story) and Study 2 (Food). Error bars represent the standard error of the mean.

Discussion

In Study 2, 4-year-olds predicted that a child who was not present during the study would be equally likely to know a well-known dish (pizza) and a novel dish that participants invented. This pattern of responding demonstrates that 4-year-olds overestimated who shared their knowledge of a novel food that participants had just invented during the study. As this new child (Sam/Alex) was not present during the study, this new child could not know the novel dish participants had invented. Nonetheless, 4-year-olds predicted that there was an equal likelihood that this new child could know the novel dish and a well-known dish (pizza). Six-year-olds did not make this overestimation error, instead predicting that this new child would be more likely to know a well-known food than a novel food. Importantly, the findings of Study 2 replicate the overestimation error that 4-year-olds made in Study 1. Because

stories and foods are examples of knowledge items that would typically be cultural knowledge (Király et al., 2017; Liberman et al., 2016; Shutts et al., 2009, 2013; Tsosie, 2002), we expected that children should make the same kind of overestimation error for these two examples of cultural knowledge items. In both studies, 4-year-olds overestimated who shared their knowledge of a novel cultural knowledge item (story in Study 1, dish in Study 2). Study 2 provides evidence that 4-year-olds did not simply make a story specific error in Study 1, but rather that 4-year-olds may be likely to overestimate who shares their knowledge of typically cultural knowledge items if these items should not be shared in a typical way. Additionally, Study 2 provides evidence against the possibility that the act of naming something facilitated 4-year-olds performance when predicting who shared their knowledge of a novel person. All children were asked to provide the same ‘funny names’ for the dish in Study 2, yet 4-year-olds still made this overestimation error when predicting whether someone should know their novel dish. Interestingly and contrary to their reasoning in Study 1, 4-year-olds also predicted that this new child would be equally likely to have general knowledge (alphabet) and personal knowledge (bedroom colour). However, in line with the results of Study 1, 6-year-olds predicted that a new child would be more likely to have general knowledge than personal knowledge.

General Discussion

Two studies show that 4-year-olds (but not 6-year-olds) are more likely to overestimate who shares their knowledge if the knowledge item being predicted is an example of typically cultural knowledge rather than typically episodic knowledge. Study 1 finds that 4-year-olds predict another child (who was not present) would be equally likely to know a well-known story and a novel story that participants invented during the study, overestimating the likelihood that a child who was not present would share knowledge of the novel story. Importantly, 4-year-olds predicted that another child would be more likely to

know a well-known person than a person that participants had just invented, demonstrating that 4-year-olds did not overestimate who shares knowledge of their novel person. 6-year-olds did not make this overestimation error, understanding that a child who was not present would be more likely to know both a well-known person and story than a novel person or novel story. Study 2 replicates the overestimation effect seen when 4-year-olds predicted how a novel example of typically cultural knowledge is shared, with 4-year-olds predicting a child who was not present would be equally likely to know a well-known food and a novel food that participants had just invented. Like stories, we propose that foods are an example of a cultural knowledge item that is selectively shared by members of the same social groups or communities (Király et al., 2017; Liberman et al., 2016; Shutts et al., 2009, 2013; Tsosie, 2002). Again, 6-year-olds did not make this overestimation error, predicting that a child who was not present would be more likely to know a well-known food than a novel food. Taken together, these studies provide evidence that 4-year-olds (but not 6-year-olds) make a consistent overestimation error when predicting how novel examples of cultural knowledge should be shared with others. Crucially, 4-year-olds do not make this overestimation error when predicting how a novel example of episodic knowledge is shared.

We propose that 4-year-olds overestimated who shared their knowledge of a novel story and a novel food because stories and foods are examples of cultural knowledge. Infants and young children view stories and foods as associated with social or cultural groups, for example expecting people who speak the same language to share food preferences and using stories for cultural transmission of information through generations (Király et al., 2017; Liberman et al., 2016; Shutts et al., 2009, 2013; Tsosie, 2002). Cultural knowledge items are typically widely shared among the social groups that they are associated with and previous literature suggests that young children have robust intuitions about the kinds of information that tend to be culturally shared (e.g., language, songs, places, stories, foods; Begus et al.,

2016; Marno et al., 2016; Soley & Aldan, 2020; Soley & Spelke, 2016). We propose that children are forming intuitions about the kinds of items that are typically associated with social groups, view these items as cultural knowledge, and predict who shares cultural knowledge differently than other types of knowledge (e.g., episodic). We contrast cultural knowledge with episodic knowledge (people) in this study. Often, we gain knowledge of individuals through specific events or experiences, such as meeting them personally or hearing about them from another person we know. This means that while we can have well-known individuals, knowledge of people is typically an example of episodic knowledge, in which you need access to a piece of information (e.g., a person) in order to know them.

We asked participants to create a novel example of a cultural knowledge item, meaning that this particular item should not be shared in a way that is typical for cultural knowledge (i.e., the child had just made up the specific story in Study 1 and food in Study 2, so only they should know it). We propose that 4-year-olds found it challenging to restrict their knowledge predictions when predicting who should share a novel cultural knowledge item, as a knowledge prediction heuristic which considers how different types of knowledge are typically shared should initially lead children to predict that examples of cultural knowledge items are widely shared between social group members. Thus, this initial prediction would cause children to overestimate who should know their novel cultural item (i.e., the novel story or novel food). However, because children still had information about this new child that they could use to inform their episodic knowledge predictions (i.e., that the child was not present while participants created their novel person), 4-year-olds did not make this overestimation error when asked to predict who shares novel episodic knowledge.

Six-year-olds did not make the same overestimation error as 4-year-olds in Study 1 or in Study 2, showing consistency in their predictions of who should share novel cultural and episodic knowledge. This finding is in line with other research demonstrating a decrease in

the Curse of Knowledge as children age (Birch & Bloom, 2003, 2004). One possibility for this developmental difference stems from the increases in inhibitory control that are observed between 4 and 6 years (Diamond & Taylor, 1996; Gerstadt et al., 1994; Macdonald et al., 2014). Some researchers have suggested that increased inhibitory control may lead to better performance on tasks which require children to consider others' mental states (e.g., Carlson & Moses, 2001). Therefore, it is possible that with increases in inhibitory control, 6-year-olds were better able to restrict their typical cultural knowledge predictions when predicting a novel item than 4-year-olds were. This may be especially true given that we predict the knowledge prediction heuristic children use to make their knowledge predictions considers the type of knowledge being predicted in order to select which information about an individual to consider in order to predict their knowledge. When predicting how widely shared a cultural knowledge item is, children appear to view cultural knowledge items as shared among members of the groups these items are associated with (e.g., Liebal et al., 2013; Shutts et al., 2013; Soley & Aldan, 2020). In order to predict how a novel cultural item should be shared, children would need to inhibit this initial prediction and adjust it given the unique circumstances of predicting a novel item that children had just created (e.g., 'adjust' their initial knowledge prediction; Nickerson, 1999). The need to inhibit the initial prediction generated by such a heuristic, alongside increases in inhibitory control between 4 and 6 years, may have contributed to the developmental difference observed between the age groups in our sample.

A second possibility is that more extended social experience interacting with people who have a diverse range of knowledge sets may have facilitated 6-year-olds' predictions. If an initial prediction caused 4-year-olds to predict that someone who was not present would still know a novel cultural item, the extended social experience that children have by age 6 might have assisted them in adjusting this initial prediction, thereby tuning the knowledge

prediction heuristic through integrating their social and communicative experiences. In New Zealand, it is typical for children to attend school from 5-years-old. Because a school setting provides children with experience communicating with other children and adults from a range of backgrounds and with diverse knowledge sets, 6-year-olds may have greater experience needing to adjust their typical knowledge predictions. For example, children may bring a food item in their lunch box that other children do not recognise or suggest a game to play that their peers had not heard of. The increase in experiences of a person's knowledge set violating your predictions (much like the common ground violation model posed by Keysar et al., 1998) may have facilitated 6-year-olds' reasoning about how their novel cultural knowledge items should be shared. Understanding whether inhibitory control scores correlate to the likelihood of children making an overestimation error will provide further information on whether better inhibition of an initial response contributes to a reduction of overestimation errors in older children.

At the end of each study, we asked participants to predict whether the new child we described would have general knowledge (knowledge of the alphabet) and personal knowledge (knowledge of participants' bedroom colour). Because we hypothesized that children would make overestimation errors when items were shared in an atypical way, we included these questions to better understand how children reasoned about a stranger's knowledge when the items being predicted should be shared in a way that is typical for those items. That is, a new child should be more likely to know the alphabet (general knowledge item) than the colour of participants' bedrooms (personal knowledge item). In Study 1, both 4-year-olds and 6-year-olds predicted that a child who was not present should be more likely to know the alphabet than the colour of participants' bedrooms, demonstrating an understanding of the way that personal knowledge and general knowledge may typically be shared with a stranger. However, in Study 2, only 6-year-olds predicted knowledge would be

shared in this way, with 4-year-olds predicting that a stranger could be equally likely to know the alphabet and the colour of participants' bedrooms.

While it is possible that 4-year-olds may not understand how different kinds of knowledge are typically shared with a stranger, it is unlikely that this is the case due to the 4-year-olds in Study 1 predicting a difference in the likelihood of a stranger knowing general and personal knowledge. It is also possible that 4-year-olds who participated in Study 2 may have reasoned about general and personal knowledge differently than those we sampled in Study 1. However, the consistency in 4-year-olds responses across the two cultural knowledge conditions (Story in Study 1; Food in Study 2) provides some initial evidence against this idea. Another possibility is that 4-year-olds in Study 2 may have developed a 'Yes' response bias throughout the study. In Study 2, 4-year-olds predicted that a new child would know the well-known dish, would know the novel dish, and would know the alphabet. Because the bedroom colour question was always the final or penultimate question of the study, 4-year-olds may have been influenced by their previous responses. This would not have been true for participants in the person condition, as even 4-year-olds judged that this new child would not know something (i.e., their novel person). Interestingly, in the story condition, 4-year-olds tended to respond 'Maybe' to both the well-known and novel story questions (see Table 4) and 'Yes' to the alphabet question, again demonstrating variability in their use of the available responses. Because only 4-year-olds in Study 2 had consistently answered 'Yes' during the course of the study, these previous responses may have influenced 4-year-olds more in Study 2 than in Study 1.

Though the results from Study 1 and Study 2 are in line with our predictions, we cannot conclusively say that the overestimation errors seen in 4-year-olds were due to an initial prediction generated by the proposed knowledge prediction heuristic. Though we predict that children view stories and foods as examples of cultural knowledge, we did not

rule out the possibility that children view these items as general knowledge shared by everybody. If children do view these knowledge items as general knowledge, this too could lead children to overestimate knowledge of stories and foods (but not people), as children may reason that a typically general knowledge item is shared by everyone. However, if children are treating these items as general knowledge, this would have implications for the function of the heuristic proposed. For example, it may mean that children are considering how widely shared an item and predicting how it is shared based on that, rather than viewing specific items as examples of cultural knowledge and predicting whether individuals are likely to share cultural knowledge based on their characteristics. Additionally, though we replicated 4-year-olds overestimation error in Study 2, we did not replicate the episodic knowledge condition. We predict that 4-year-olds would not overestimate other examples of episodic knowledge, because the novel episodic item in this study can still be predicted using the typical information used to predict episodic knowledge items (i.e., access to a piece of knowledge). Nonetheless, replicating the episodic knowledge condition would give us more confidence that 4-year-olds are demonstrating different reasoning for episodic knowledge items than more widely shared knowledge items (e.g., cultural, general).

What do these results indicate about the process children use to predict others' knowledge? First, the results of this study are in line with empirical evidence suggesting that children form robust intuitions about the kinds of items which tend to be shared within groups. For example, infants and young children expect food information and preferences to be widely shared by in-group members but not out-group members (Lieberman et al., 2016; Shutts et al., 2009, 2013), trust and expect to receive knowledge from native language speakers (Begus et al., 2016; Kinzler et al., 2011; Marno et al., 2016), expect songs to be known by speakers of the same language (Soley & Aldan, 2020), and perhaps even see stories as a form of transmitting cultural information through generations (Király et al., 2017;

Tsosie, 2002). There is also evidence that young children treat episodic information in a different way from cultural knowledge, not expecting episodic knowledge to be shared without observable access to an event or experience (i.e., being present while the rules of a game were taught, Wyman et al., 2013; being present while taught how to care for a novel animal, Köymen et al., 2016). The current studies provide evidence in support of this idea as well, with 4-year-olds showing a distinct difference in their reasoning about typically episodic and typically cultural pieces of information. The observed difference in reasoning for cultural and episodic knowledge items suggests that children may have early intuitions about categories of knowledge and further, that young children may already understand how pieces of information which come from different knowledge categories are typically shared in distinct ways.

This overestimation error seen in 4-year-olds may also provide some evidence for the process that children are using when predicting which other people share their knowledge. We propose that children use a knowledge prediction heuristic which considers how specific types of knowledge (e.g., episodic, cultural) are typically shared in order to assist them in making efficient and mostly accurate knowledge predictions. However, use of this knowledge prediction heuristic may actually lead children to produce this overestimation error if knowledge of an item should not be shared in a way that is typical for that item. That is, if children use a heuristic which assumes that cultural knowledge items are typically widely shared among people from the same social groups, using this heuristic when predicting knowledge of a novel cultural item would lead children to overestimate how widely shared that piece of knowledge is. Importantly, children could not have used experience with predicting an individual's knowledge state (as this child was a stranger), nor could children have used experience predicting how this particular piece of knowledge was shared (as children created the novel items during the study). Instead, these studies provide evidence for

the use of a knowledge prediction heuristic that children use to make generalizable predictions about others' knowledge.

Four-year-olds in our study made overestimation errors only when reasoning about cultural knowledge items. However, there is a possibility that using a knowledge prediction heuristic could lead children to make overestimation errors when predicting episodic knowledge, if the episodic knowledge item should not be shared in a way that is typical for episodic knowledge. In the current studies, children were able to predict their partner's episodic knowledge using information about presence and absence while children created their novel items. In cases where a person's presence during an event may not lead them to have a piece of episodic knowledge (i.e., someone who is present while the rules of a game are verbally explained but is wearing headphones), it is possible that children may again overestimate how knowledge is shared. There is some evidence against this possibility, with studies demonstrating an early understanding of the relationship between perceptual access and knowledge (Gopnik & Graf, 1988; Pillow & Weed, 1997; Terrier et al., 2016; Wimmer et al., 1988). For example, 3-year-olds understand that a puppet could not know what was inside a container if this puppet was present (and moved the container) but did not have perceptual access to the container's contents (Pillow, 1989). Thus, it seems like young children may be less likely to overestimate episodic knowledge generally, even when the episodic knowledge should not be shared in an entirely typical manner.

If 4-year-olds are using a knowledge prediction heuristic in order to make efficient predictions about who would typically share knowledge of cultural items, this would raise an interesting question about how use of this heuristic changes throughout childhood and into adulthood, especially given the developmental difference observed in these studies. One possibility is that we continue using such a heuristic to predict others' knowledge and incorporate our experiences encountering those who do and do not share our knowledge to

fine tune or adjust these initial predictions. In fact, use of a quick prediction and adjustment process could mean that older children and even adults may make interpretable errors in their knowledge predictions in some circumstances (e.g., when needing to predict knowledge very quickly (leaving less time to adjust any initial predictions) or when under a higher cognitive load). Anecdotally, it would not be unusual for older children or adults to overestimate someone's knowledge when required to predict knowledge quickly (e.g., during communication). We may be surprised that a friend has not seen a movie which we consider a classic, even though we have no information that would lead us to predict that this particular friend might have seen it (i.e., knowledge access). Further, we may even do this if we have information suggesting that a particular friend might be more likely to have *not* seen this movie (i.e., your friend does not like this particular genre or is not a big movie person). Understanding how overestimations of knowledge occur in older children and adults may provide evidence of both the process that we use to consider others' knowledge sets and how this process changes throughout development.

Though we need to consider the knowledge states of those around us regularly, we do not make perfect knowledge predictions all of the time. Because of the trade-off between efficiency and accuracy when predicting others' knowledge, children may be prone to making overestimation errors. These studies provide evidence that these overestimation errors may be indicative of an adaptive shortcut process, allowing even young children to predict who should typically share different pieces of their knowledge. Additionally, the selective overestimation error when predicting how novel examples of cultural knowledge should be shared with others provides insight into the kinds of items that children view as typically shared within social groups. As children age and gain experiences encountering people with varying knowledge sets, this extended experience alongside increases in

inhibitory control may scaffold a more nuanced understanding of how children predict their knowledge is shared with others.

Chapter 4

The results of Chapter 3 show 4-year-olds are more likely to overestimate who shares a piece of novel cultural knowledge than novel episodic knowledge. I argue that these young children are using a heuristic which predicts that cultural knowledge items are typically widely shared within the social groups and communities these items are associated with, leading children to predict that a novel example of a cultural item (which should not be shared as children had just invented it) would be shared with another child of the same age who was not present during the study. Chapter 3 also finds an interesting developmental difference between 4-year-olds and 6-year-olds, namely that by age 6, children may no longer make this overestimation error for cultural knowledge items. It is possible that increases in inhibitory control (e.g., Carlson & Moses, 2001; Diamond & Taylor, 1996; Macdonald et al., 2014) and communicative experience may facilitate older children's ability to adequately adjust their cultural knowledge predictions.

Using a heuristic would be adaptive when predicting knowledge because we often need to predict knowledge quickly while communicating with others (Brown-Schmidt, 2009; Clark & Brennan, 1991; Nadig & Sedivy, 2002) but we also need to make knowledge predictions that are accurate most of the time, as inaccuracies can cause communicative errors (Grice, 1969, 1975; Noveck & Reboul, 2008; Okanda et al., 2015). Chapter 4 examines how predicting an increase in shared knowledge may cause another overestimation error. Namely, Chapter 4 examines whether characteristics of the individual whose knowledge is being considered may lead children to overestimate how much episodic information is shared (i.e., which objects someone can see). I predict that, like adults, an increase in shared knowledge will lead to a reduced feeling of need to visually perspective take, thus causing perspective taking errors if children's perspective does not match their partner's perspective, creating a mismatch in the episodic information shared between partners.

Shared Social Groups or Shared Experiences?

The effect of shared knowledge on children's perspective-taking.

Abstract

Young children can consider others' visual perspectives to interpret ambiguous communication. However, perspective-taking is a cognitively costly process, and though children can consider the visual perspectives of others, children occasionally make perspective-taking errors. What causes children to reduce their consideration of a partner's visual perspective? Two studies examine whether sharing knowledge with a communicative partner influences how 4- to 6-year-olds consider a communicative partner's perspective. Participants completed in the director task (a perspective-taking game) which requires children to consider what a partner can see to interpret an ambiguous instruction. In Study 1, children played with a similar partner who was from the same place as the participant (and shared cultural knowledge with the participant) and a dissimilar partner who was from a different place than the participant (and did not share the participant's cultural knowledge). Social group similarity did not affect children's consideration of their partner's perspective. However, in Study 2, participants made more perspective-taking errors when playing the director task with their parent or caregiver (who shares prior episodic knowledge with participants) than when playing with a stranger (who does not share any prior episodic knowledge with participants). These findings highlight that shared episodic knowledge, familiarity, or closeness with a partner (but not simply shared social group membership and shared cultural knowledge) may influence young children's perspective-taking. The role of shared knowledge overestimations in causing a reduced feeling of need to perspective-take is discussed.

Keywords: social cognitive development, perspective-taking, shared knowledge, theory of mind, closeness-communication bias

Throughout social interactions, we are often required to consider specific information we share with a partner or a partner's perspective in order to communicate clearly. For example, you might tell a friend to look towards 'their left', rather than simply to 'the left' in order to reduce the possible locations you could be referring to. Providing this extra information allows for smooth and efficient communication with fewer possible meanings for a listener to interpret. However, speakers do not always provide enough information to entirely disambiguate each statement. This means that listeners are often also required to consider which information is shared between themselves and the speaker. If a colleague asked you to pass them 'that pen', you may consider referential cues to your colleague's perspective (e.g., where they are looking or pointing) to help you disambiguate which pen your colleague is asking for. As a listener, considering the speaker's perspective (such as what the speaker can see or what has been mentioned previously) can allow us to interpret a message that may otherwise be ambiguous.

While it's important that a message is conveyed clearly between communicative partners, we do not have unlimited time or resources to spend disambiguating each statement. A Gricean view of communication argues that we require a balance between efficiency (using the minimum resources necessary to convey our message) and effectiveness (ensuring the correct message is conveyed; Grice, 1969; Grice, 1975). While we could spend an immense amount of time disambiguating every statement, for the sake of efficiency a speaker can often rely on the fact they share information with their communicative partner which the communicative partner can use to interpret a pared-down statement (Ackerman et al., 1990; Glucksberg & Krauss, 1967; Hanna et al., 2003; Sperber et al., 2010). That is, we can use information that we predict is shared between ourselves and our communicative partners (i.e., common ground; Clark, 1996; Clark & Brennan, 1991) in order to interpret ambiguous communication or communicate more efficiently (Heller et al., 2012; Keysar et al., 2000).

For example, you may use the information that you can see your colleague writing on a whiteboard to help you determine that your colleague is asking for a whiteboard pen rather than a ball point pen, without your colleague completely disambiguating exactly which pen they require.

How do we know what is in common ground with a specific communicative partner? We do not usually discuss what is in common ground when communicating, as this would undermine the efficiency benefit of considering common ground. One way that we might predict what is in common ground is through considering various cues that may provide insight about a partner's perspective (perspective-taking; Glucksberg & Krauss, 1967; Horton & Keysar, 1996; Nadig & Sedivy, 2002). By making inferences about what a communicative partner can see, is currently attending to, or has discussed previously, we can predict which information is in common ground and which is privileged information known by just one partner, thereby reducing communicative ambiguity (Brown-Schmidt, 2009; Brown-Schmidt & Hanna, 2011; Hanna et al., 2003). For example, when given an ambiguous instruction (e.g., "Move the triangle on top of the red one"), participants quickly and selectively focus on red items that the speaker can also see (items in common ground; Hanna et al., 2003) in order to reduce the ambiguity of the speaker's instruction. Predicting which knowledge or information is shared between communicative partners is essential in order to achieve clear but efficient communication (Tannenhaus et al., 1995; Keysar et al., 2000; Nadig & Sedivy, 2002).

Interestingly, there is evidence that young children predict what is in common ground when communicating with others from early in development. Young children use referential cues, such as what someone has seen or heard, in order to make inferences about the information that is in common ground (Köymen et al., 2014, 2016). For example, 3-year-olds expect peers to adhere to the rules of a game but only if a peer was present to learn the rules

(meaning that the rules were information in common ground; Wyman et al., 2009). 3-year-olds can also predict which common ground they share with strangers from the same social groups, predicting that a stranger in the same location would know a well-known cultural figure (Santa Claus) but not a novel figure (Sand Man; Liebal et al., 2013). There is evidence that even toddlers use predictions about what is in common ground to resolve an ambiguous request. When asked to help an adult retrieve ‘the toy’, 24-month-olds gave this adult a toy that was mutually visible rather than a toy that only toddlers could see (Moll & Tomasello, 2006), suggesting that 2-year-olds are already using referential cues to make inferences about what is in common ground. Further, older children use information about what is or is not in common ground to modulate their own communication. Four-year-olds selectively explain pieces of information that are not in common ground in order to rectify a partner’s false belief (Bass et al., 2019) and 5- to 6-year-olds provide general and explanatory information when told that a partner does not know something (e.g., “Cups are for drinking”) but will highlight more specific information if told a partner does know something already (e.g., “Cup has polka dots”; Baer & Friedman, 2018). This empirical evidence suggests that young children infer what is in common ground with a partner and moreover, integrate common ground information to modulate their communicative interactions with others.

Despite the benefits of considering a partner’s perspective and children’s early ability to consider which information is in common ground, it appears that both children and adults make perspective-taking errors (Epley et al., 2004; Keysar, 2007; Keysar et al., 2003). One task that is often used to investigate perspective-taking errors is called the director task (Epley et al., 2004; Keysar et al., 2000; Nadig & Sedivy, 2002; Nilsen & Graham, 2009). In the director task, participants are asked to sit on one side of a grid and a communicative partner (often a confederate) to sit on the opposite side of this grid. The grid is divided into slots with various items placed inside these slots (see Figure 1 for an example). Some of these

slots are visible to people sitting on both sides of the grid but others are occluded from the confederate's side, meaning that only the participants can see inside these slots. Importantly, there are often two or more items that are identical or fit the same description (e.g., having a bouncy ball in one slot and a tennis ball in another slot) and participants are given an ambiguous instruction to retrieve one of these items (e.g., "Next, pick up the ball"). This ambiguity means that participants need to consider which of these items their communicative partner can see (which item is in common ground) in order to select the ball that their partner was likely referring to. Adults and children regularly show initial egocentrism in their response to the ambiguous requests (i.e., by looking towards the objects that their communicative partner cannot see) and children occasionally fail to inhibit this initial egocentrism, leading children to incorrectly respond to ambiguous requests (Epley et al., 2004). This egocentrism, or lack of consideration about what is in common ground, may result in communicative errors or slower responses (Barr, 2008; Epley et al., 2004; Keysar & Barr, 2002; Savitsky et al., 2011), including providing an incorrect response to an ambiguous request (Savitsky et al., 2011) or taking longer to process an ambiguous request (e.g., Barr, 2008).

One study suggests that when participating in the director task, adults and 4- to 12-year-olds show similar initial egocentrism in their responses to ambiguous requests (i.e., adults and children are equally likely to first look towards the object which is not in common ground), but adults show better correction of this egocentrism than children do (by later selecting the item which is in common ground; Epley et al., 2004). However, other studies using the director task suggest that 5- and 6-year-old children selectively fixate on items that are in common ground from the earliest stages of language processing (Nadig & Sedivy, 2002), showing an efficient consideration of referential cues to their partner's perspective in order to interpret an ambiguous request. Though some researchers originally argued that

children's perspective-taking errors were due to an inability to consider others perspectives (e.g., Mossler et al., 1976; Piaget & Inhelder, 1956), the findings that young children (Fan & Liberman et al., 2015; Nadig & Sedivy, 2002; Nilsen & Graham, 2009) and infants (Liberman, Woodward, Keysar, et al., 2017; Moll & Tomasello, 2006) can accurately perspective-take in some contexts suggest that it is more likely our perspective-taking accuracy fluctuates. If perspective-taking is central to creating effective and efficient communication, what causes us to regularly make perspective-taking errors?

One paper has recently argued that perspective-taking is a cognitively costly process, so we adjust our levels of perspective-taking based on the expected division of labor between social partners (Hawkins et al., 2020). The authors argue that we use a 'resource-rational' model to determine the need to consider a partner's perspective; that is, we weigh up the probability of needing to consider a partner's perspective in order to understand their communication with the relative cognitive cost of actually considering their perspective. This model predicts that because perspective-taking is effortful, we do not employ perspective-taking consistently throughout communication, but rather we actively consider a partner's perspective when the perceived benefit of considering their perspective outweighs the cognitive cost. This model would explain why we occasionally make perspective-taking errors because we may sometimes perceive the cognitive costs of perspective-taking to outweigh the benefits of considering a partner's perspective, causing communicative errors if there was, in fact, a need to perspective-take. Which factors influence our perceived need to perspective-take during a communicative interaction? Does our perceived feeling of need to perspective-take influence perspective-taking accuracy?

Life experiences which require us to consider others' perspectives often may facilitate our understanding of when it is necessary to consider perspectives more generally. Children who are bilingual, or even with exposure to more than one language, show better perspective-

taking during a communicative interaction than their monolingual counterparts (Fan & Liberman et al., 2015). This effect is found in infants as young as 14- to 17-months-old, even though they do not yet fluently speak either language (Liberman, Woodward, Keysar, et al., 2017). Regularly considering what others will understand or the perspectives of others (e.g., having to switch languages when speaking with different individuals) may facilitate an increase in the accuracy of our judgments on when we need to perspective-take more generally. Other researchers have focused on how increases in shared knowledge when communicating with someone similar to yourself may affect our consideration of their perspective. There is some evidence that communicative errors increase with increases in the amount of knowledge shared between the two partners. Adults were more likely to use privileged information (i.e., knowledge that participants did not share with their communicative partner) when communicating with partners who shared a lot of their task knowledge than partners who shared little information with participants (Wu & Keysar, 2007). When completing the director task, participants took longer to make decisions and selected more incorrect items when the director was a friend than a stranger (Savitsky et al., 2011). The researchers in this study argue that increases in shared knowledge when communicating with someone close to us may actually cause us to overestimate what is in common ground, leading to communicative errors.

Thus, establishing a bank of shared knowledge with a partner may in fact alter how likely we are to consider their perspective. A resource-rational model of perspective-taking during communication (Hawkins et al., 2020) may predict that we would show increased perspective-taking for a partner with whom we share little prior common ground. With little prior information about common ground or shared experiences, we may experience a heightened feeling of need to perspective-take when communicating with a dissimilar other. That is, the benefits of ensuring effective communication outweigh the cognitive costs of

having to consider a dissimilar partner's perspective. We may communicate effectively with a partner who shares a lot of our knowledge when our perspectives are not mismatched, as we can rely on information that truly is shared in order to interpret ambiguous instructions or requests (Fussell & Krauss, 1989; Greenaway et al., 2015; Todd et al., 2016). For example, it is very efficient to ask a colleague to send you 'that paper' if you are both aware which paper is being referred to (e.g., from it being referred to previously or in visual common ground). However, this efficiency benefit disappears if your colleague does not share this common ground with you and needs to clarify which paper you mean. When communicating with a similar partner with whom we share a bank of information already, we may feel less need to consider their perspective due to the assumption that your perspectives are likely to be aligned (due to overestimations of information that is in common ground). Yet if there is a perspective mismatch or we overestimate how much knowledge is shared with a similar partner, this may cause an increase in communicative errors (Savitsky et al., 2011; Simpson & Todd, 2017; Wu & Keysar, 2007). Not considering a similar partner's perspective would reduce the cognitive cost of communication with minimal decreases in communication effectiveness but may lead to inaccuracies when your perspective does not match the perspective of a similar partner.

Having prior shared experiences with a partner is not the only factor that may lead to an increase in shared knowledge. We often share knowledge with people who are in the same social groups or communities as ourselves, even if we have never met them before (cultural common ground; Clark, 1996). For example, you may share knowledge of local landmarks, slang, or even cultural songs and dishes with strangers who live in the same place as yourself (see Clark et al., 1983; Isaacs & Clark, 1987; Liberman et al., 2016; Liebal et al., 2013; Shutts et al., 2013; Soley & Aldan, 2020). Moreover, adults and children can predict which people share cultural knowledge when provided information about their social group

memberships. Adults will use the proper names for local buildings only when speaking to a partner who is also local (and will therefore share knowledge of the proper names; Isaacs & Clark, 1987) and 5- to 6-year-olds expect people who speak the same language (but not those who speak different languages) to share knowledge of songs (Soley & Aldan, 2020). As increases in shared knowledge appear to cause reduced perspective-taking (Savitsky et al., 2011; Wu & Keysar, 2007), it is possible that the increase in shared cultural knowledge when communicating with a partner from the same social groups or communities as yourself may also lead to an increase in perspective-taking errors.

Despite the findings that young children can perspective-take (Moll & Tomasello, 2006; Nadig & Sedivy, 2002; Nilsen & Graham, 2009), and that infants' and young children's perspective-taking is influenced by life experiences (like adults; e.g., bilingualism; Fan & Liberman et al., 2015; Liberman et al., 2017), the effect of assumed shared knowledge on children's perspective-taking has not been examined. Young children are capable of predicting which knowledge they share with others using referential cues (e.g., what someone has seen; Köymen et al., 2016; Wyman et al., 2009) and can predict which knowledge they share with strangers from the same social groups (i.e. cultural knowledge; Goldvicht-Bacon & Diesendruck, 2016; Liebal et al., 2013; Soley & Aldan, 2020). Thus, it is possible that an increase in predicted shared cultural knowledge will reduce children's perspective-taking as it appears to in adults (Savitsky et al., 2011; Wu & Keysar, 2007). Importantly, we aim to separate the effect of shared knowledge specifically on perspective-taking. By studying children, we remove a portion of the communicative experience, knowledge of different social groups, and biases that adults have due to their extended life experiences, allowing us to examine the role of shared cultural knowledge warranted by changes in social group similarity.

Studying how children's perspective-taking differs when communicating with partners from the same social groups and different social groups may provide insight into the role of overestimating shared knowledge when perspective-taking. Based on the finding that children are able to engage in communicative perspective-taking (Fan and Liberman et al., 2015; Nadig & Sedivy, 2002), predict who shares knowledge (Köymen et al., 2016; Liebal et al., 2013; Soley & Aldan, 2020; Wyman et al., 2009), and the effect of shared knowledge on adult's perspective-taking (Fussell & Krauss, 1989; Savitsky et al., 2011; Van Der Wege et al., 2021; Wu & Keysar, 2007), the current study examines whether social group similarity to a partner (and therefore increases in assumed shared cultural knowledge) reduces children's perspective-taking accuracy. We predict that increases in predicted shared knowledge when communicating with a partner from the same social groups will lead to children considering this partner's perspective less than when communicating with a partner from different social groups with whom children share less cultural knowledge.

Study 1

In Study 1, we investigate how social group similarity with a stranger influences perspective-taking in 4- and 6-year-old children. Children participated in a perspective-taking game (the director task; Epley et al., 2004; Fan & Liberman et al., 2015; Keysar, 2007; Nadig & Sedivy, 2002; Savitsky et al., 2011) which required them to consider a partner's visual perspective in order to select the correct object out of a grid. To assess the effect of partner similarity on perspective-taking, children played with 2 partners: a similar partner (shared location, shared knowledge, and shared accent) and a dissimilar partner (different location, different knowledge, and different accent). We manipulated accent and location as young children treat accent as a strong marker of group membership (Floccia et al., 2009; Kinzler et al., 2011; Weatherhead, Friedman, et al., 2018; Weatherhead, White, et al., 2018) and expect even strangers from the same location to share cultural knowledge (Liebal et al., 2013; Soley

& Aldan, 2020). Additionally, the partner's expressed knowledge that the participant did share (similar partner) or did not share (dissimilar partner) to explicitly highlight that the similar partner did share some knowledge with participants (i.e., knowledge of a well-known TV show). Children played with two experimenters who they had no contact with prior to the experiment and we manipulated similarity to the two partners by providing group membership information during the experiment.

A resource-rational model of perspective-taking argues that we are more likely to actively perspective-take when we judge that it is necessary throughout communication (Hawkins et al., 2020). We may quickly predict how much information is in common ground in order to decide when to actively consider a partner's perspective, thus explaining some of the variation in perspective-taking performance. If children predict that their perspective is similar to a partner from the same social group and this causes a reduced feeling of need to consider a similar partner's perspective, we predict that children will make more perspective-taking errors when playing with a similar partner. While relying on shared knowledge may usually enable efficient communication with a similar partner, participants will always have a different perspective than their partner during this task which may instead lead to perspective-taking errors. This would be consistent with the findings that perspective-taking is reduced when communicating with a similar other (Savitsky et al., 2011; Simpson & Todd, 2017; Wu & Keysar, 2007).

Method

Participants

Twenty-four 4-year-olds ($M=54.65$ months, 12 males) and twenty-four 6-year-olds ($M=76.85$ months, 12 males) participated in the current study. All participants were typically developing children from a mid-size city in New Zealand recruited from a database of families interested in participating in research on child development. Data was collected

between May 2017 and July 2018. Three additional children were excluded for failing the memory check ($n=1$), experimenter error ($n=1$), or choosing to stop the study ($n=1$).

Stimuli and Design

Participants were asked to move items commonly known to young children (e.g., a cup, a toothbrush, a ball) around a 4x4 shelf (16 slots; see Figure 1). Four slots in the shelf were occluded from one side. The items were in a fixed position in the shelf across children, but the order of the item sets and the items each partner asked for were counterbalanced, such that sometimes the similar partner and the dissimilar partner requested each target item. We also counterbalanced the order of the partners, such that half of participants played with the dissimilar partner first and half played with the similar partner first.

Procedure

Children completed a version of the director task closely modelled from the procedure of Fan and Liberman et al., (2015) who also examined perspective-taking in 4- to 6-year-old children. The participant was brought into the testing room and sat at a child sized chair in front of the shelf. The experimenter explained the purpose of the game, namely that the goal was to move the objects inside the shelf to their correct places. Children then participated in a practice trial where they gave the experimenter instructions on how to move things around the shelf first. Children were taken to the far side of the shelf and asked to put on dark sunglasses. The similar and dissimilar partner (adult confederates) later wore these sunglasses during the task to avoid any eye gaze cueing, so this step was done to ensure that all children knew that the shelf could be seen through the sunglasses. In the first two practice trials, the child was instructed to ask the experimenter to move a singular object with no competitor around the shelf (e.g., “Move the cellotape above the butterfly”). On the third and fourth practice trials, the child was instructed to ask for an object of which the child could see one, but the experimenter could see two. The experimenter always selected the object that was not

visible to the child to demonstrate an egocentric error. The experimenter asked if the object was correct and when children objected, guided children to repeat the instruction. Following this, the experimenter would move the correct object. The experimenter told children explicitly that some of the squares were blocked meaning that from one side of the shelf, some of the items were hidden.

Children were then told that they were going to be introduced to their two game partners. The two partners were brought into the testing room individually and sat on child sized chairs opposite the child. When they were not playing the game, the partners were instructed to read a book that had been placed on their chair. During the consent procedure, the experimenter asked the parent to record where the child lived and select a TV show or book that the child regularly watched or read and enjoyed from a provided list of popular books and shows in New Zealand. During the study, the experimenter asked each partner where they were from and whether they knew about the TV show or book the child enjoyed. The similar partner spoke in a New Zealand accent, said that she lived in the same city as the child, knew about the same TV show or book as the child, and provided a fact about that show or book for validation. The dissimilar partner spoke in a foreign accent, said that she lived in a different country (Disentis), didn't know about the TV show or book that the child knew but did know about another TV show or book (Obwah) and provided a novel fact about that TV show or book. The experimenter asked children to point to the partner that lived in each place as a memory check. If children failed this memory check, the introduction process and memory check was repeated until children answered correctly.

Children completed 2 grids (6 trials) with each partner; 2 non-perspective-taking trials with no competitor object, 2 perspective-taking trials with a duplicate object occluded from their partner's view, and 2 scalar perspective-taking trials where the partner requested the 'small' object and the smallest object was occluded from their partner's view (see Figure 5). After

these 6 trials, the child was told that they were now going to play the game with the second partner. Upon completion of the 12 test trials, the experimenter placed a picture of each partner above their head on the wall and asked the partners to leave the room. Children were asked to point to the picture of the similar and dissimilar partner to ensure they remembered which partner was which (*i.e.*, “*Can you point to the girl that lives right here in [where child says they live] and knows [item child knows]? Okay! And who lives in very faraway in Disentis and knows about O-Bwah? Okay!*”), and one child was excluded from the analyses for failing to pass this final memory check. Children were then asked to indicate how similar each partner was to themselves on a 4-point Likert scale (1=Really not like me, 2= A little not like me, 3= A little like me, 4=Really like me) and additionally which partner they would like to play the game with again as a measure of preference.

Figure 5. Two example grids including objects for a scalar perspective-taking trial (Left Grid, “Move the small candle [to location]”; Right Grid, “Move the small truck [to location]”), two object perspective-taking trial (Left Grid, “Move the dinosaur [to location]”; Right Grid, “Move the book [to location]”), and no perspective-taking trial (Left Grid, “Move the clock [to location]”; Right Grid, “Move the shoe [to location]”)

Coding

Two cameras recorded the participant during the study: one was positioned on top of the shelf to record children's eye gaze, and the second was positioned behind the participant facing the shelf to record their responses to the instructions. Our coding scheme closely replicated that of Fan and Liberman et al., (2015). For each trial, an offline coder was asked to record whether the participant first looked to the target object or the distractor object (i.e., the left side of the grid or the right side of the grid, as target and competitor objects were always on opposite sides), and the object that children moved within the shelf. If children touched or moved one object, we coded the first object that children moved to another location. The coder also indicated whether children responded 'similar partner' or 'dissimilar partner' to the questions at the end of the study. The coders were blind to condition, so were unaware when the child was playing with a similar or dissimilar partner. A reliability coder coded 25% of trials; coding reliability for items moved and responses to questions was 100%, while eye gaze reliability was 98.59%. We used coding from a third coder who was blind to condition for any trials with coding disagreements and we used the coding from the first coder for other children as intercoder reliability was high.

Results

As in Fan and Liberman et al. (2015), we began by scoring the first look and reach each trial with a '1' for a correct response (selecting or looking to the target object) and a '0' for an incorrect response (selecting or looking to the distractor object). We calculated trial latency from the onset of the target noun to the child touching the object they later moved within the shelf. We also calculated recovery (making an incorrect first look but moving the target object) and incorrect switching (making a correct first look but moving the distractor object) on each trial for each child. We included this measure as children sometimes show

initial egocentrism but subsequent corrections of their egocentric first reactions (Epley et al., 2004; Nilsen & Graham, 2009).

We conducted a binomial logistic regression in order to analyse the effect of partner similarity (2; similar, dissimilar) and trial type (2; perspective-taking, non-perspective-taking) on children's object choices. We chose to run a binomial logistic regression to account for the binomial nature of children's responses (correct object, incorrect object) across repeated trials, and the model included partner and trial type as fixed predictors of children's responses and participant as a random predictor to control for the interdependence on repeated trials. The model showed no significant interaction between partner and trial type (Wald $\chi^2 = 1.38$, $df = 1$, $p = .24$), and there was no significant main effect of partner similarity on children's correct reaches (Wald $\chi^2 = .01$, $df = 1$, $p = .92$). As expected, the model showed a significant main effect of trial type (Wald $\chi^2 = 185.27$, $df = 1$, $p < .001$, see *fig. 6*) where performance was higher on the non-perspective-taking trials ($M = .99$, $SD = .05$) than the perspective-taking trials ($M = .52$, $SD = .30$; see Figure 2). Model fit was not significantly improved when adding age as a continuous covariate (Wald $\chi^2 = .50$, $df = 1$, $p = .481$), participant gender (Wald $\chi^2 = .30$, $df = 1$, $p = .585$) or counterbalancing order (Wald $\chi^2 = 4.32$, $df = 5$, $p = .505$). Children were also equally as likely to select 100% of the correct objects with the similar partner ($n = 4$) and the dissimilar partner ($n = 5$; $\chi^2 = .123$, $p = .726$).

Next, we analysed participant's first look during perspective-taking trials in order to assess the effect of partner similarity on children's initial egocentrism. This model showed no effect of partner similarity on children's first looks towards the target object (Wald $\chi^2 = .91$, $df = 1$, $p = .338$). Model fit was significantly improved when age in months was added as a continuous covariate (Wald $\chi^2 = 4.95$, $df = 1$, $p = .026$) suggesting an overall increase in correct first looks on perspective-taking trials with an increase in age, but there was no interaction between age and partner similarity (Wald $\chi^2 = .40$, $df = 1$, $p = .53$). There were no

effects of participant sex (Wald $\chi^2 = .01$, $df = 1$, $p = .915$) or counterbalancing order (Wald $\chi^2 = 6.54$, $df = 1$, $p = .477$) on correct first looks. Partner similarity had no effect on rates of recovery (incorrect first look but correct reach; Wald $\chi^2 = .21$, $df = 1$, $p = .65$) or incorrect switching (correct first look but incorrect reach; Wald $\chi^2 = .55$, $df = 1$, $p = .457$).

We examined the latency of children's object choices to see whether partner similarity affected how long children took to make a decision. There was no significant effect of partner similarity on latency in the perspective-taking trials ($t(69.24) = 0.92$, $p = .36$) but there was a significant effect of partner similarity on the non-perspective-taking trials ($t(60.972) = 2.69$, $p = .009$) where children took longer to make decisions when playing with a dissimilar partner ($M = 5085\text{ms}$, $SD = 2805\text{ms}$) than the similar partner ($M = 3917\text{ms}$, $SD = 1094\text{ms}$). It is possible that this effect was simply due to children taking longer to interpret instructions in a different accent (e.g., Bent, 2014; Munro & Derwing, 1995; Nathan et al., 1998).

To examine whether children were viewing the similar partner as more like themselves than the dissimilar partner, we compared children's similarity ratings for each partner and their preferred partner to play a game with again. This demonstrated that children rated the similar partner ($M = 3.0$, $SD = .86$) as significantly more like themselves than the dissimilar partner ($M = 2.5$, $SD = .94$; $t(46) = 2.29$, $p = .027$), and would choose to play with the similar partner again ($n = 37$) significantly more often than to play with the dissimilar partner ($n = 10$; $p < .001$, two tailed binomial). This suggests that our similarity manipulation was effective, though similarity did not affect children's perspective-taking.

Figure 6. Children's target object choices (perspective-taking and non-perspective-taking) and first looks (perspective-taking). '*' denotes a significant main effect of trial type in Study 1. Error bars represent standard error of the mean.

Discussion

The results from Study 1 demonstrate that manipulating social group similarity did not affect children's perspective-taking. In fact, partner similarity did not influence any of our measures of perspective-taking, including object choices, latency, initial first looks towards an object, and recovery or incorrect switching. Further, responses on these measures did not differ between age groups in our sample, demonstrating that age had no effect on how children considered a similar and dissimilar partner's perspective (note that we are comparing rates of perspective-taking between partners, rather than overall perspective-taking ability which may increase with age; e.g., Epley et al., 2004; Mossler et al., 1976; Nilsen & Graham, 2009). Importantly, this does not appear to be because our similarity manipulation was not

effective. Children rated the similar partner as more similar to themselves than the dissimilar partner and would prefer to play with the similar partner again more often than the dissimilar partner (in line with research demonstrating an in-group preference in children; Aboud, 2003; Bigler et al., 1997; Mahajan & Wynn, 2012). This null finding also cannot have been because the task was not tapping into perspective-taking. Children made fewer correct reaches on perspective-taking trials than non-perspective-taking trials, and rates of choosing the correct object in perspective-taking trials are consistent with previous findings using this paradigm (e.g., monolingual children in Fan & Liberman et al., 2015). Furthermore, it is also unlikely that the null effect of similarity on perspective-taking was because children did not assume shared knowledge with the similar partner. Four- to 6-year-old children do predict shared knowledge with a stranger from the same location (e.g., cultural figures, Liebal et al., 2013; song knowledge, Soley & Aldan, 2020) and the similar partner explicitly expressed one piece of shared knowledge with children during the study (i.e., TV show or book knowledge). Therefore, these null results seem to suggest that social group similarity does not influence children's perspective-taking in this task.

Why did social group similarity not affect children's perspective-taking? One possibility is that predicting a greater bank of shared knowledge does not affect children's visual perspective-taking in the same way that it appears to for adults. The previous research examining the effect of shared knowledge with a communicative partner on subsequent perspective-taking has been studied exclusively in adults (e.g., Savitsky et al., 2011; Wu & Keysar, 2007a) and it is possible that children's perspective-taking is not influenced by broader assumptions of shared knowledge. Though children can consider others' knowledge during communicative interactions (Baer & Friedman, 2018; Köymen et al., 2016; Wyman et al., 2009), children may not have the wealth of successful and unsuccessful perspective-taking experiences needed for children to alter their perspective-taking with specific partners.

This may mean that though children do predict shared cultural knowledge and consider the perspectives of their communicative partner, shared knowledge predictions may not influence the perspective-taking process in the same way that it appears to for adults. Additionally, it is possible that adults typically bear most of the communicative labour when communicating with children (i.e., actively tailor their communication to a child's perspective), meaning that children may often experience successful communication even without needing to perspective-take themselves (Hawkins et al., 2020). This could lead to the effect of shared knowledge on perspective-taking being less pronounced in children, given their experiences of successful communication without considering a partner's knowledge or perspective.

Another intriguing possibility is that shared knowledge *does* influence children's perspective-taking but the type of partner similarity or amount of shared knowledge matters in order for children to feel a difference in their perceived need to perspective-take. The research studying how shared knowledge may influence adults' perspective-taking operationalises shared knowledge in various ways, including increases in shared task-specific knowledge (Wu & Keysar, 2007) and increases in prior shared knowledge or communicative experiences (i.e., communicating with friends and strangers; Savitsky et al., 2011). While there is evidence suggesting that children do predict shared knowledge with strangers from the same social groups (Goldvicht-Bacon & Diesendruck, 2016; Liebal et al., 2013; Soley & Aldan, 2020), it is possible that children require a larger bank of shared knowledge with a partner (i.e., knowledge of shared events, prior communicative experiences) in order to perceive a reduced feeling of need to consider that partner's perspective. It is also possible that feelings of closeness with a partner who you know well (e.g., a friend) may influence this feeling of need to perspective-take (as suggested by Savitsky et al., 2011).

Study 2

In a pre-registered Study 2

(https://osf.io/ge2kf/?view_only=03721593a45d48769fe10e9ba1ee2634), we investigate whether children's perspective-taking differs when communicating with someone who they share extensive prior knowledge with (their parent or caregiver) and someone who children have never met before (an unfamiliar experimenter). Rather than playing with two unfamiliar experimenters who differed in social group similarity to the child, participants played with a familiar partner who was close with children and with whom children shared a lot of prior knowledge (their parent or caregiver) and an unfamiliar partner who was not close with the participants and with whom children share no prior knowledge (a research assistant they had no prior contact with).

If predictions of shared knowledge do not influence children's perspective-taking (as these predictions do for adults; Savitsky et al., 2011, Wu & Keysar, 2007a), children should show no difference in their perspective-taking between their caregiver and a stranger. This finding would be consistent with the idea that adults typically bear most of the communicative labour when communicating with children, meaning that children do not feel a difference in their need to perspective-take when communicating with adults (even if the specific adults may vary in how much knowledge they share with the child; Hawkins et al., 2020). However, it is possible that only specific kinds of shared knowledge may influence children's perspective-taking with a partner (i.e., knowledge of prior shared events or experiences) or that feelings of closeness with a partner may influence children's perspective-taking. If so, children's perspective-taking should decrease when communicating with a close partner with whom they share knowledge of numerous prior events and experiences (their caregiver). Additionally, the cognitive cost of considering their caregiver's perspective may seem higher than any potential benefit, as children already have a wealth of successful communicative experiences with their parents or caregivers.

Method

Participants

Forty-eight 4- to 6-year-olds participated in the current study ($M = 65.34$ months, 22 males). All participants were typically developing children from a mid-size city in New Zealand recruited from a database of families interested in participating in research on child development and none of the children had participated in Study 1. Data was collected between February 2019 and July 2020. Three additional children were excluded for not following instructions ($n = 1$), procedural error ($n = 1$), or parental interference ($n = 1$).

Procedure

Participants in this study completed the same director task as in Study 1, either with their caregiver or with an unfamiliar experimenter. Neither caregivers nor experimenters were provided information about the purpose or hypotheses of the study beforehand. We did not give caregivers or experimenters any training, but they were provided with a sheet of instructions upon arriving in the lab (see supplementary materials). As each caregiver only completed the task with their own child or children, the unfamiliar experimenter was also switched across studies to ensure that the experimenters were not practiced. During the study, a second experimenter who ran the procedure placed written instructions on the partner's side of the shelf and told partners to read these instructions verbatim. Both children and partners were told that only this second experimenter was allowed to answer questions or provide additional information during the study. To keep social group similarity information consistent across partners, all unfamiliar partners had a New Zealand accent, and no other similarity information was provided during the study.

The procedure ran similarly to Study 1 with a few key differences. Children completed 4 grids with one partner, and each grid contained only one perspective-taking trial and one no perspective-taking trial. This meant that children completed 4 perspective-taking

trials and 4 non-perspective-taking trials across the study. Because a floor effect could reduce our ability to detect any differences in children's perspective-taking, in order to improve children's perspective-taking performance generally, we removed the scalar perspective-taking trials and asked children to simply remove the items from the grid and place them into a basket. Lastly, at the end of the perspective-taking game, children were asked how easy or hard they thought the game was and 36 participants completed an additional executive functioning task with their partner (day night task; Gerstadt et al., 1994). During the day night task, the experimenter showed children cards with a picture of either a sun or moon on them. Children were instructed to say 'Day' when shown the picture of the moon and 'Night' when shown the picture of the sun, meaning children need to inhibit a typical response to respond correctly (i.e., 'Day' for the sun picture, and 'Night' for the moon picture). The experimenter completed 4 practice trials with the child to ensure they understood the instructions and then asked the caregiver or unfamiliar experimenter to show children the remaining 16 test cards. This additional task was included to ensure that any differences observed between partners were not due to differences in attention or motivation to complete the game. Coders used the same coding protocol as in Study 1 (Fan & Liberman et al., 2015) and a reliability coder coded 25% of trials. Coding reliability for items moved and responses to questions was 100%, while eye gaze reliability was 98.95%. We used coding from a third coder who was blind to condition for any trials with coding disagreements and we used the coding from the first coder for other children as intercoder reliability was high.

Results

In our pre-registration, we noted that we would use parametric testing to analyze the data (anova, t-test). However, upon further consideration of the non-parametric data and design, we decided that using a binomial logistic regression is more appropriate in order to control for the repeated trials with a binomial outcome that we conducted. As in Study 1, we

began by scoring the first look and reach each trial with a '1' for a correct response (selecting or looking to the target object) and a '0' for an incorrect response (selecting or looking to the distractor object), and calculated trial latency, recovery, and incorrect switching on each trial for each child.

We conducted a binomial logistic regression to analyse the effect of partner familiarity (2; caregiver, stranger) and trial type (2; perspective-taking, non-perspective-taking) on children's correct object choices (i.e., selecting the mutually visible object). This model found a significant interaction between partner familiarity and trial type on children's correct object choices (Wald $\chi^2 = 5.39$, $df = 1$, $p = .02$; see Figure 7). While children's correct object choices didn't differ when playing with a caregiver ($M = .98$, $SD = .07$) or a stranger ($M = .94$, $SD = .11$) when completing non-perspective-taking trials (Wald $\chi^2 = 2.14$ $df = 1$, $p = .14$), there was a numerical difference in children's correct object choices for their caregiver ($M = .69$, $SD = .31$) and the stranger ($M = .81$, $SD = .28$) in the perspective-taking trials, though this was not significant (Wald $\chi^2 = 2.77$ $df = 1$, $p = .096$). The model fit was not significantly improved when adding participant gender (Wald $\chi^2 = .72$, $df = 1$, $p = .394$), counterbalancing order (Wald $\chi^2 = 3.15$, $df = 7$, $p = .87$), or age in months as a continuous covariate (Wald $\chi^2 = .02$, $df = 1$, $p = .90$). We also examined whether children were more likely to get 100% of the trials correct when playing with a parent or an experimenter as noted in our pre-registration and examined by Fan and Liberman et al., (2015). Interestingly, children were significantly more likely to select 100% of the correct objects with the stranger ($n = 15$) than their caregiver ($n = 8$; $\chi^2 = 4.09$, $p = .043$).

We examined the effect of partner familiarity on the latency of children's object choices. During the perspective-taking trials, there was a significant effect of partner familiarity on latency ($t(116.04) = 1.98$, $p = .05$) showing children took longer to make decisions when playing with their caregiver ($M = 5498\text{ms}$, $SD = 3329\text{ms}$) than a stranger (M

= 4195ms, $SD = 1224$ ms). There was no difference in latency between partners on the non-perspective-taking trials ($t(159.84) = -.16, p = .87$).

As in Study 1, we examined whether children's correct first looks towards the target object differed by partner familiarity on the perspective-taking trials. This model showed no effect of partner familiarity on children's correct first looks (Wald $\chi^2 = .12, df = 1, p = .727$). The model fit was not significantly improved when adding age in months (Wald $\chi^2 = .37, df = 1, p = .545$), participant gender (Wald $\chi^2 = .80, df = 1, p = .371$), or counterbalancing order (Wald $\chi^2 = 11.64, df = 7, p = .11$). Partner familiarity had no effect on rates of recovery (incorrect first look but correct object choice; Wald $\chi^2 = 1.29, df = 1, p = .257$) or incorrect switching (correct first look but incorrect object choice; Wald $\chi^2 = .04, df = 1, p = .851$).

Finally, we compared performance on the executive function (day night) task for the caregiver and the stranger. We calculated the proportion of correct responses for each child out of the 16 cards presented, as 3 children were not shown all 16 cards by their partner (because the participant chose to stop part way through, or two cards were stuck together and the partner did not notice). A two-sample t-test showed no significant effect of partner on children's correct responses during the day night task ($t(33.64) = .013, p = .896$). Children also rated the game as equally 'easy' when playing with their caregiver or a stranger ($t(39.24) = -.84, p = .408$).

Figure 7. Children's correct object choices (perspective-taking and non-perspective-taking) and first looks (perspective-taking) during Study 2. '*' denotes a significant interaction between partner familiarity and trial type. Error bars represent standard error of the mean.

Discussion

The findings from Study 2 provide some evidence that children's perspective-taking may differ when communicating with a familiar partner (their parent or caregiver) and an unfamiliar partner (an unfamiliar adult). During perspective-taking trials, children made marginally fewer correct reaches when playing with a familiar partner than an unfamiliar partner, and fewer children selected all of the correct objects when playing with a familiar partner than an unfamiliar partner. Children also took longer to make decisions when communicating with a familiar partner during perspective-taking trials. Partner familiarity did not affect children's performance in the non-perspective-taking trials or the inhibitory control

task, demonstrating that this effect appears to specifically influence perspective-taking rather than task performance generally. As in Study 1, participant age did not affect children's responses. However, we found no partner differences in any of the eye gaze measures during perspective-taking trials (i.e., correct first look, recovery, incorrect switching). Children also rated the task as equally easy when playing with either partner.

Study 2 suggests that children's feeling of need to perspective-take may be altered when communicating with specific adults, particularly if an adult shares a large bank of prior knowledge with the child or if children feel close to an adult. Though there was a numerical difference between children's correct object reaches for their caregiver and a stranger, this was not significant. However, we did find consistency in the direction of this trend across other measures. Children were more likely to make all of the correct object reaches when playing with a stranger than when playing with a caregiver, and children took longer to make decisions when playing with a parent than with a caregiver. This provides evidence against the idea that children do not feel the need to consider adults' perspectives more generally, given that adults may usually present information to a child from the child's perspective reducing the need for children to typically consider a partner's perspective (Hawkins et al., 2020). Instead, the results of Study 2 provide initial evidence that feelings of closeness to a partner or larger amounts of shared prior knowledge may cause a decrease in children's perceived need to perspective-take.

General Discussion

Two studies examined how sharing knowledge with a communicative partner affects children's perspective-taking. Study 1 examined the effect of social group similarity (and predicted increases in shared cultural knowledge) on children's perspective-taking and demonstrated that social group similarity did not influence how children considered their communicative partner's perspective. Importantly, children in Study 1 did feel more similar

to the partner who was a member of the same social groups, indicating that the similarity manipulation created differences in how similar participants felt to each partner.

Additionally, previous literature suggests that children do infer shared cultural knowledge with in-group members from the same location (part of the similarity manipulation used; Goldvicht-Bacon & Diesendruck, 2016; Liebal et al., 2013; Soley & Aldan, 2020), meaning that it is likely children understood that they shared cultural knowledge with the similar partner. However, the findings of Study 1 suggest that simply sharing cultural knowledge with a partner does not produce differences in children's perspective-taking. Interestingly, Study 2 provides evidence that children's perspective-taking may be reduced when playing with a familiar partner who children share a lot of prior knowledge and personal experiences with, however, some results show only a marginal difference. Children in Study 2 took marginally longer to consider their caregiver's perspective than a stranger's perspective and children tended to make less correct object choices when playing with a caregiver than with a stranger. Fewer children responded correctly to all of the perspective-taking instructions when playing with a caregiver than a stranger. Though some of the results demonstrate trends rather than statistically significant results, these findings all trend in the direction predicted by our hypotheses. Thus, though we need to exercise caution in our interpretation of these results, there is initial evidence that children's perspective-taking may be influenced familiarity, closeness, or prior shared experiences with a partner, but not by shared social group membership alone.

One possibility for the marginal results seen in Study 2 could be due to our sample being underpowered to detect small effects. We conducted an a priori power analysis using the effect size from a study that used the director task with children of the same age (Fan & Liberman et al., 2015), however, the effect examined was differences in monolingual and bilingual children's perspective-taking. The effect sizes observed in Study 2 are smaller than

the bilingualism effect seen in prior research, thus our sample may have been underpowered limiting our ability to detect small alterations in perspective-taking. If our sample was underpowered, this may have limited our ability to detect an effect of partner on children's perspective-taking. Though our sample is typical for studies in social cognitive development conducted with this age group, replicating this study with a larger sample would give us more confidence in the trend observed in Study 2, and the null effect observed in Study 1.

Alternatively, it is possible that the difference in children's perspective taking when communicating with a familiar and close partner is truly smaller than the effect seen in adults (Savitsky et al., 2011; Wu & Keysar, 2007). It is possible that extended communicative experience is needed in order for children to start adjusting their levels of perspective-taking to communicate more efficiently, or that shared knowledge does not affect children's feeling of need to perspective-take as greatly as it seems to in adults. Closely examining differences in how children and adults alter their perspective-taking when communicating would provide information on the variables influencing perspective-taking for familiar and close partners (e.g., communicative experiences, increase in shared knowledge causing a reduction in perceived need to perspective-taking).

It is possible that children's perspective-taking is less influenced by partner characteristics than adults' perspective-taking. Adults appear to perspective-take less when they share a greater bank of knowledge with a communicative partner (Wu & Keysar, 2007) or when communicating with a partner they know well (a friend; Savitsky et al., 2011). Thus, we predicted that a reduction in perspective-taking would occur due to children wanting to be efficient in their perspective-taking (i.e., only considering a partner's perspective when the benefits outweigh the cognitive costs; Hawkins et al., 2020) and therefore perceiving a reduced need to perspective-take when a greater bank of shared knowledge was already shared. If children initially perceived their perspective to be similar to their partners, we

predicted that children may reduce their active consideration of a communicative partner's perspective in order to maintain efficiency while communicating. While it is possible that children do not yet aim to be efficient in their perspective-taking, the findings demonstrating that 5- to 6-year-olds focus on items in visual common ground from the earliest stages of language processing (Nadig & Sedivy, 2002) and expect others to be efficient when communicating (Morisseau et al., 2013) suggest that children already value efficiency during communication. Therefore, it is possible that predictions of shared knowledge alone are not enough for children to begin to adjust their levels of perspective taking during a communicative interaction.

Studies in adults have demonstrated that increases in shared knowledge are associated with a reduction in perspective-taking, both when sharing task specific knowledge with strangers (i.e., novel shape names; Wu & Keysar, 2007a) and when communicating with a close friend (leading to increased episodic knowledge via prior shared experiences; Savitsky et al., 2011). In both of the current studies, children could have predicted an increased amount of shared knowledge with one partner; cultural knowledge (knowledge shared by members of the same social groups) due to shared social group membership with the similar partner in Study 1, and prior episodic knowledge (knowledge of events and experiences) due to communicating with a parent or caregiver in Study 2. Yet, we only saw evidence that children's perspective-taking was influenced when we compared their responses for a caregiver and a stranger. Why was children's perspective-taking unaffected by the social group manipulation used in Study 1?

One possibility for the null effect seen in Study 1 is that predicting a greater bank of shared cultural knowledge with a partner does not influence children's considerations of their partner's perspective or the items which are in an episodic form of common ground (i.e., visual common ground). That is, it is possible that greater amounts of shared *cultural*

knowledge do not influence more *episodic* knowledge predictions in children. Relatedly, it is possible that shared knowledge inferences do not influence lower-level processes, such as considering what someone can see, when required to communicate quickly as is typical during a conversation or game. Wu and Keysar (2007a) found that when a participant shared knowledge of a large proportion of novel shape names with a partner (as opposed to only a small proportion of novel shape names), the participant was more likely to overestimate how many other shape names their partner knew. Importantly, the overestimation of knowledge found in this study was also of episodic knowledge (i.e., knowledge of shape names). Savitsky et al. (2011) also measured overestimations of episodic knowledge when communicating with partners who vary in amount of shared episodic knowledge. Participants played with a friend (with whom we typically share a wealth of episodic knowledge of shared experiences and events) and a stranger (who we typically do not share any prior episodic knowledge with). In this study, participants more frequently overestimated how much episodic information (items in visual common ground) that their partner shared when playing with a friend than a stranger. It is possible that estimating how much cultural knowledge is shared between partners may not influence adults' or children's estimations of which episodic knowledge is shared. Because in Study 1 children shared cultural knowledge with their partner but no prior episodic knowledge, children may not have overestimated how much episodic information their partner shared, resulting in a lack of perspective-taking differences between similar and dissimilar partners.

By nature of having prior shared knowledge, a partner may also feel more close or more familiar to us. People that we share episodic knowledge with will be more familiar to us than a partner that we do not have any shared experiences with, and people who share cultural knowledge with us may also feel familiar or close due to a similarity in background. Feelings of familiarity or closeness with a partner could lead to a reduced feeling of need to

perspective-take too, perhaps due to personal experiences considering a familiar partner's perspective previously or due to a sense of familiarity leading participants to overestimate how similar their perspective is to a familiar partner (Van Der Wege et al., 2021), or causing participants to overestimate how similar their perspective is to a partner that they feel close to (Savitsky et al., 2011). Shared episodic knowledge, familiarity, and feelings of closeness are all related, such that a change in one variable is likely to influence the others. For example, by sharing episodic events and experiences with a partner, you are becoming more familiar with them. Increased familiarity also seems to lead to increased preference (Monin, 2003; Rindfleisch & Inman, 1998), perhaps thereby increasing how close you feel with a partner. Because of the conceptual overlap between these variables, it is difficult to say which (or which combination) may be influencing children's perspective-taking in Study 2. That is, it is possible that increases in shared knowledge led to a reduction in perceived feeling of need to perspective-take, but it is also possible that feelings of closeness to a partner lead to a reduction in perceived feeling of need to perspective-take.

Prior literature examining reductions in perspective-taking acknowledges both the role of shared knowledge and feelings of closeness, but there is not clear evidence that demonstrates one of these variables influences perspective-taking more than the other. Wu and Keysar (2007) find that sharing an increased amount of task specific knowledge with a stranger was enough to induce communicative perspective-taking errors. As participants communicated with strangers, this suggests that shared knowledge is the contributing factor to this reduction in perspective-taking, rather than feelings of closeness or familiarity. However, the act of learning things together may mean participants felt closer to the partner with whom they also shared an increased amount of task knowledge. One other recent study finds that adults show reduced perspective-taking when interpreting an ambiguous sentence spoken by a stranger from the same minimal group than a different minimal group (i.e.,

randomly assigned as an ‘overestimator’ or an ‘underestimator’ in an unrelated task; Van Der Wege et al., 2021). Because participants in this study demonstrated reduced perspective-taking when communicating with a stranger from the same minimal group, it is very unlikely that familiarity or feelings of closeness with a partner alone is influencing adults’ responses. Instead, it is more likely that an overestimation of shared knowledge with strangers who share characteristics with us may cause adults to reduce their consideration of a partner’s perspective. However, the authors note that even a minimal groups manipulation may cause participants to feel closer to a partner who they are told shares a characteristic with them, and this closeness may lead to a reduction in perceived feeling of need to consider this partner’s perspective (as opposed to shared knowledge causing this reduction). Future research is needed in order to understand whether a change in perspective-taking is observed in situations where shared knowledge and feelings of closeness are manipulated more independently.

Though it is often important for us to consider a communicative partner’s perspective, adults and children regularly make errors while perspective-taking (Barr, 2008; Epley et al., 2004; Keysar, 2007). Perspective-taking is a cognitively costly process (Hawkins et al., 2020), meaning that we only consider a partner’s perspective when we perceive a mismatch in our perspective and our partner’s perspective. Though it seems like overestimating the knowledge you share with a communicate partner may hinder our considerations of their perspective, shared social group member did not affect children’s perspective-taking. However, communicating with a caregiver who was both familiar and close with participants appeared to decrease the participants consideration of their perspective. This may suggest that predictions of shared knowledge do not impact the feeling of need to perspective-take in children, in the same manner that shared knowledge appears to affect adults’ perspective-taking. Nevertheless, we did see a trend towards children’s reduced consideration of their

caregivers' perspective, suggesting that other variables including feelings of closeness or familiarity may influence children's perspective taking. Studies that carefully manipulate the role of closeness, familiarity, and shared knowledge are needed to further examine how children consider and integrate these variables when responding to an ambiguous request.

Chapter 5

General Discussion

The three papers presented in this dissertation provide evidence for the early use of a knowledge prediction heuristic that allows young children to consider and predict others' knowledge. Further, these studies provide evidence for the factors children must consider to facilitate the early use of this knowledge prediction heuristic and find signature errors during children's early use of this knowledge prediction process. I predicted that young children would use a knowledge prediction heuristic to predict shared knowledge, which functions via taking information about the individual whose knowledge was being predicted and information about the way that different types of knowledge (e.g., cultural, episodic, general) are typically shared to make quick and generalisable knowledge predictions. I predicted that this knowledge prediction heuristic must function by considering which type of knowledge is being predicted because the information needed to predict cultural knowledge (information on social group memberships) is different than the information needed to predict episodic knowledge (information about knowledge access) or general knowledge (typically widely shared regardless of information about knowledge access or social group membership). Further, I also predicted that the heuristic must subsequently consider how information about an individual (e.g., social group memberships when predicting cultural knowledge; knowledge access when predicting episodic knowledge) is predictive of their knowledge state.

Chapter 2 provides evidence that 3- to 6-year-old children selectively predict who shares their own cultural knowledge and understand that novel cultural knowledge is typically shared between those who live in the same place. While children used information about an individual's geographic location to predict shared cultural knowledge (e.g., knowledge of a local museum or how to count to 10 in a local language), children did not use

information about shared interests or possessing the same sticker to adjust their shared knowledge predictions, nor did children use any group membership information to adjust their predictions when predicting how general knowledge is shared. This suggests that children have intuitions about the kinds of group memberships that are important to consider when predicting knowledge and treat general knowledge differently than cultural knowledge, at least in this study. In Study 2, 3- to 6-year-olds predicted that children from the same location should be more likely to share novel pieces of cultural knowledge than children who were the same age, meaning that children must already have early intuitions about which kinds of knowledge items (e.g., songs, dishes, landmarks, languages) tend to be cultural knowledge and therefore shared within members of specific groups or communities. Children expected procedural knowledge to be shared by strangers who were the same age rather than those from the same location, demonstrating that children do not think that people who live in the same place are more likely to share all types of knowledge. However, children expected strangers from the same location to share episodic knowledge even though children were informed that the two strangers did not know each other. As children did not require personal experience with the individuals whose knowledge was being predicted or the specific knowledge items being predicted, children cannot rely on experience alone to facilitate their shared knowledge predictions.

Chapter 3 tested whether children make predictable overestimation errors when predicting how cultural knowledge is shared, thus providing evidence for the use of a knowledge prediction heuristic. Children were asked to create a well-known and novel knowledge item, which were either examples of typically episodic knowledge (i.e., people) or typically cultural knowledge (i.e., stories and dishes). Four-year-old children reasoned that someone who was not present could know about a well-known cultural (e.g., The Gruffalo in Study 1, Donaldson, 1999; Pizza in Study 2) and well-known episodic knowledge item (Elsa

from Frozen, Buck & Lee, 2013), predicted that someone who was not present could not know about a novel episodic item that participants had just invented, but overestimated whether this individual should share knowledge of a novel cultural knowledge item that participants had just invented. Because 4-year-olds did not make this overestimation error when predicting how the novel episodic knowledge item would be shared, this overestimation error seems to be specific to knowledge that is an example of a typically cultural knowledge item. Interestingly, 6-year-olds did not make this overestimation error, predicting that a stranger would know both well-known items but would not know either of the novel items, regardless of whether the items were typically examples of episodic knowledge or cultural knowledge). This predicted overestimation error may be due to 4-year-olds making typically adaptive and generalisable assumptions about the way that cultural knowledge items are usually shared. That is, cultural knowledge tends to be widely shared within the social groups that it is associated with and children have early intuitions about the way that certain opinions or affiliations are associated with social group membership (e.g., food preferences and song knowledge being shared by native language speakers; Begus et al., 2016; Király et al., 2017; Liberman et al., 2016; Liebal et al., 2013; Shutts et al., 2009; Soley & Aldan, 2020). This means that it is usually adaptive for children to predict that cultural knowledge items are widely shared within social groups or communities. However, when presented with a novel cultural knowledge item which should not be shared by other social group members, 4-year-olds failed to inhibit this initial prediction leading to an overestimation of shared cultural knowledge.

Chapter 4 examined whether shared social group memberships (and an inferred increase in shared cultural knowledge) would reduce 4- to 6-year-olds consideration of a partner's perspective during a communicative perspective-taking task. We predicted that an increase in overall shared knowledge may cause children to show less communicative

vigilance and overestimate how similar their visual perspective was to a partner. Contrary to some of the previous research demonstrating the influence of shared knowledge on perspective-taking in adults (Savitsky et al., 2011; Wu & Keysar, 2007), an inferred increase in shared cultural knowledge did not appear to influence children's real time consideration of a partner's perspective. In Chapter 4, communicating with a stranger who was a member of the same social groups or a member of different social groups did not influence 4- to 6-year-olds perspective-taking, despite the difference in shared cultural knowledge between these two partners and the participant. However, when perspective-taking with a caregiver or a stranger in Study 2, we found a trend suggesting that 4- and 6-year-olds may consider the perspective of their caregiver less than the perspective of a stranger. One possible explanation is that not all kinds of shared knowledge reduce children's perspective-taking and increases in shared cultural knowledge do not affect children's feeling of need to perspective-taking. Alternatively, it is possible that shared knowledge generally does not influence children's perspective-taking in the same way it seems to for adults (Savitsky et al., 2011; Van Der Wege et al., 2021; Wu & Keysar, 2007), and that feelings of closeness or familiarity with a partner drives the trend suggesting a reduction in perspective-taking when children communicate with a caregiver.

What do these findings presented in this dissertation tell us about the heuristic that children use to predict others' knowledge? First, I will discuss the findings of Chapter 2 and Chapter 3 which highlight a difference in children's treatment of cultural knowledge from other knowledge categories. I argue that even young children create conceptual boundaries between different types of knowledge (e.g., cultural knowledge, episodic knowledge, general knowledge) facilitate predictions about how specific knowledge items are shared. I will discuss how the findings presented throughout this dissertation help to disentangle the factors that children's proposed knowledge prediction heuristic uses to predict others' knowledge.

Namely, I argue that from a young age, children do not solely rely on experience with knowledge items (e.g., children do not need to have visited a country to understand that locals share knowledge of songs, landmarks, or the language) or experience with an individual (i.e., prior experience with this particular individual's knowledge set that children could use to guide future predictions) to predict their knowledge set. Instead, I argue that young children have intuitions about the kinds of knowledge items that form different types of knowledge (i.e., episodic, cultural, general), the way that these different types of knowledge are typically shared among individuals and groups, and that children can use this information to produce generalisable and efficient predictions about others' knowledge sets.

Secondly, I will examine evidence of signature errors that stem from a heuristic being a mental shortcut and occasionally producing incorrect or incomplete predictions. I will consider the reasons why children overestimated who would share knowledge of a novel cultural knowledge they had just invented in Chapter 3, but children's perspective-taking performance was unaffected by increases in shared cultural knowledge in Chapter 4. Namely, while young children may overestimate who is likely to share a novel piece of cultural knowledge as a result of using the knowledge prediction heuristic I propose, increases in shared knowledge may not result in a lack of communicative vigilance when considering a stranger's perspective. Instead, it is possible that the trend suggesting reduced perspective-taking when communicating with a caregiver may be due to children typically sharing the same perspective as their caregiver, feeling 'close' to their caregiver, or sharing prior episodic knowledge with their caregiver.

Third, I will discuss the developmental changes of a knowledge prediction process between 3 and 6 years, focusing on the age difference found in Chapter 3 and the lack of age effects in Chapters 2 and 4. I suggest that children begin using this knowledge prediction heuristic early in development, and subsequently begin to refine the initial predictions

generated by this heuristic with increases in communicative experiences, experiences predicting a diverse range of knowledge sets, and in other cognitive processes such as inhibitory control. Finally, I discuss the importance of shared knowledge predictions during communication and discuss future research avenues to investigate how a knowledge prediction heuristic may facilitate efficient and effective communication from early in development.

Are there conceptual boundaries between knowledge types?

Do children split knowledge into different knowledge types? Throughout this dissertation, I have categorised knowledge into distinct knowledge types including episodic knowledge, cultural knowledge, and general knowledge. I argue that children need to consider different information when predicting each of these knowledge types, and a knowledge prediction process must therefore consider which type of knowledge is being predicted in order to accurately select and consider information relevant to predicting that type of knowledge. It is possible that children do not categorise knowledge into knowledge types, and instead view knowledge as one broad category and predict that some knowledge items are more widely or narrowly shared than other items. That is, children may simply consider the proportion of people they have encountered which do and do not know about a specific knowledge item (i.e., how widely shared it should be) and then make predictions about which other people should share this knowledge accordingly. However, I argue that children view conceptual boundaries between different types of knowledge and use these conceptual boundaries to efficiently consider information relevant to predicting how a certain type of knowledge is shared. Similar to the boundaries that Clark (1996; see also Nickerson, 1999; Royzman et al., 2003) draws between types of common ground, I argue that children categorise knowledge by knowledge type and already understand that not all types of knowledge are shared in the same manner.

If children are creating conceptual boundaries between knowledge types, we should see differences in the way that children consider and predict knowledge depending on which type of knowledge a knowledge item belongs to. When predicting who shares their own knowledge, children selectively predict that strangers from the same location share their cultural knowledge yet understand that not all social groups warrant the same shared knowledge predictions (Chapter 2). For example, children predicted that a child who lived in the same location as themselves would share location specific cultural knowledge (i.e., How to count to 10 in Te Reo Māori) but did not expect a child who simply had the same sticker to share this information. Further, children were more liberal in their general knowledge predictions and did not use social group membership information to predict who possesses general knowledge. This provides initial evidence for a conceptual boundary, in which children understand that cultural knowledge is shared in a distinct and different way than general knowledge is shared. This finding extends previous work (e.g., Liebel et al., 2013) which has shown that 5-year-old children expect speakers of the same language to share their knowledge of cultural figures (e.g., Santa Claus) but not novel figures (e.g., The Sandman). While this study does not control for the possibility that children think of cultural figures as general knowledge, Chapter 2 provides novel evidence that children do separate cultural knowledge from general knowledge and predict these knowledge types differently.

This finding is particularly interesting given young children's presumed lack of experiences communicating with those who may not share their cultural knowledge. Cultural knowledge is typically widely shared among the social groups it is associated with, meaning that young children may not have experiences interacting with individuals who do not share pieces of children's cultural knowledge. It would have been entirely reasonable for these young children to treat cultural knowledge and general knowledge in the same way, but they do not. Instead, even young children appear to have intuitions about which knowledge items

are examples of cultural knowledge and general knowledge, and then predict different types of knowledge and then adjust which information they use to make knowledge predictions based on the type of knowledge being predicted.

Interestingly, in Chapter 2 children also predicted that novel examples of cultural knowledge items (i.e., knowledge of novel foods, language, songs, and places) would be shared by those in the same location rather than those who are the same age (another relevant social group that children view as important to consider when predicting procedural knowledge). Here, children were required to predict how novel cultural knowledge was shared between groups of strangers from the same location or who were the same age (note we did not tell children which countries or which ages), removing any personal experience children had with specific knowledge items or the individuals involved. Still, children understood that novel cultural knowledge items should be shared with different groups of people (people similar in location) than procedural knowledge items (people similar in age). This highlights that from a young age, children must not only form inferences about which knowledge items are examples of cultural knowledge, but children must also understand how cultural knowledge is selectively shared by members of specific groups and communities. Further, because children in Chapter 2 reasoned that strangers from the same location are more likely to share cultural knowledge but strangers who are the same age can share procedural knowledge, children must not simply reason that cultural knowledge items are typically shared within ‘social groups’. Instead, young children must understand which types of social groups are typically associated with which cultural knowledge items and adjust their novel knowledge predictions accordingly. By using novel knowledge items which participants had no prior experience with, we provide evidence that children do not solely rely on experience to predict others’ knowledge and instead suggest that children are

considering information about the type of knowledge and the individual whose knowledge is being predicted in order to make predictions about this individual's knowledge state.

These findings are in line with other empirical evidence demonstrating that children treat some items or opinions as typically associated with members of specific social groups. For example, 5- and 6-year-olds predict that song knowledge will be shared by those who speak the same language more often than those who speak different languages, but understand that song preferences are idiosyncratic and not selectively shared within groups (Soley & Aldan, 2020; Soley & Spelke, 2016). Infants not only show a preference for native speakers (Kinzler et al., 2007) but selectively expect to receive knowledge from native speakers (Begus et al., 2016; Marno et al., 2016). Infants and young children expect food preferences to be shared by those who affiliate or speak the same language and use native language speakers' food choices to guide their own food selections (Lieberman et al., 2016; Shutts et al., 2009, 2013). The findings of Chapter 2 provide novel evidence that young children do not simply associate specific items with specific social groups or communities through experience, but instead appear to form an intuitive understanding of which types of items are typically cultural and expect knowledge of cultural items to be typically shared within specific groups and communities. Moreover, Chapter 2 and Chapter 3 provide evidence for the kinds of items that children view as 'cultural' items, and thus widely shared with members of the social groups these items are associated with (i.e., songs, Soley & Aldan, 2020; dishes, Lieberman et al., 2016, Shutts et al., 2009, 2013; languages, Lieberman et al., 2017, Begus et al., 2016; stories, Kíraly et al., 2017, Tsosie, 2002; landmarks).

Chapters 2 and 3 provide conflicting evidence about children's understanding of a conceptual boundary between cultural knowledge and episodic knowledge. In Chapter 3, children created a novel example of both a typically episodic knowledge item (i.e., people; Clark et al., 1983; Liebal et al., 2013) and a typically cultural knowledge item (i.e., stories

and foods; Király et al., 2017; Liberman et al., 2016; Shutts et al., 2009, 2013; Tsosie, 2002). Four-year-old children overestimated the likelihood that a stranger would share knowledge of a novel cultural item (i.e., a story and a dish that participants invented) but did not expect a stranger to share knowledge of a novel episodic item (i.e., a person that participants invented), demonstrating an important difference in the way that 4-year-olds reasoned about cultural and episodic knowledge. If children viewed episodic knowledge in a similar way to cultural knowledge (i.e., without a conceptual boundary between the two) and thus considered the same information when predicting cultural and episodic knowledge, 4-year-olds should have been equally likely to overestimate who shared knowledge of their novel cultural or episodic item. Yet, they were not. The difference in these findings demonstrate one key difference in the way that 4-year-olds predict episodic and cultural knowledge items are shared with others, suggesting that at least 4-year-old children may indeed view a conceptual boundary between cultural and episodic knowledge. In Chapter 2 however, 3- to 6-year-olds reasoned that strangers who lived in the same location would be more likely to share novel pieces of episodic knowledge than those who were the same age, identically to how children of this age reasoned novel cultural knowledge would be shared. This finding demonstrates similarity in the way that children reasoned about novel cultural and episodic knowledge, predicting that novel episodic knowledge may be shared by strangers from the same location in the same manner as cultural knowledge. This suggests that children may not view cultural knowledge and episodic knowledge as entirely distinct knowledge types. Do children see a conceptual boundary between cultural knowledge items and episodic knowledge items?

Two possibilities could account for the difference children's predictions of shared cultural and episodic knowledge in Chapter 2 and Chapter 3. It is possible that 3- to 6-year-olds do not see a conceptual boundary between episodic knowledge and cultural knowledge,

and that predicting which individuals know other individuals is a ‘special case’ that facilitated 4-year-olds predictions in Chapter 3. It is possible that children have more personal experience reasoning about whether individuals know other individuals (i.e., Do my family members know my friends at day care? How does a person at my house know my parents?), and this early experience in adjusting their predictions of shared ‘person’ knowledge may have facilitated 4-year-olds’ reasoning about people specifically (in Chapter 3). From a young age, even infants pay attention to and predict affiliation between social partners, even in third party tasks when both social partners are unknown to infants (Fawcett & Tunçgenç, 2017; Liberman et al., 2016, 2021; Liberman, Woodward, & Kinzler, 2017; Powell & Spelke, 2013, 2018), demonstrating an early awareness and consideration of social relationships. If reasoning about people is a special case, it is possible that children do not treat cultural knowledge and episodic knowledge as distinct categories. Instead, children may view general knowledge (and perhaps procedural knowledge as someone ages) as universally shared, and predict all other forms of knowledge using information about knowledge access alongside other indicators such as social group membership (which could indicate prior access to a piece of knowledge).

Nonetheless, there is some prior research supporting the idea that from age 3, children seem to have a robust understanding that others cannot possess episodic knowledge they have not had access to, even when they are not predicting who knows specific individuals (Koenig et al., 2015; Köymen et al., 2014, 2016; Lockhart et al., 2016; Miller et al., 2003; Wyman et al., 2009). Because young children understand that access to a piece of information is required to possess episodic knowledge (e.g., Köymen et al., 2014, 2016; Miller et al., 2003; Wyman et al., 2009), children may have reasoned that a child who was in the same location was more likely to have knowledge access (i.e., overseeing or overhearing) than a child who was in another country. This reasoning may have been especially prevalent given the forced

choice design of the task in which children were not provided with a ‘correct’ response option (i.e., a ‘Neither kid would know’ answer). Because children needed to select either the child who was the same age or the child in the same location, children may have reasoned that proximity to an event or experience is more likely to predict episodic knowledge than simply being the same age. Proximity usually does predict episodic knowledge, as direct or indirect access to an event or experience is required to know episodic knowledge. Thus, in the absence of a good response option, children may have selected the child who was more likely to have had physical access to the episodic knowledge discussed.

The second possibility is that children do not view a conceptual boundary between episodic and cultural knowledge, and instead use information such as how widely shared a knowledge item typically is or whether they can infer access to an item in order to predict it. Though there is some evidence that children view and predict episodic knowledge as a conceptually different knowledge category than cultural knowledge (Chapter 3), it is also possible that rather than treating cultural knowledge and episodic knowledge categorically, children view episodic knowledge as simply more narrowly shared than cultural knowledge and use the same kinds of information to predict knowledge items belonging to each of these knowledge types as I have described them. That is, children may use information about how many people typically know a knowledge item (e.g., where a local museum is) and use information about inferred access to that knowledge item (e.g., living in close proximity to the local museum) to infer that a local is more likely to have knowledge of this knowledge item than someone who lives further away (and is therefore less likely to have had access to it). The literature suggesting that children need to observe an individual’s knowledge access to attribute episodic knowledge (e.g., Köymen et al., 2016; Pillow, 1989; Pillow & Weed, 1997; Wyman et al., 2009) and the literature suggesting that children do *not* need information about knowledge access to attribute cultural knowledge (e.g., Liebal et al., 2013; Soley &

Aldan, 2020) suggests against this possibility. Thus, it may be more likely that children do view a conceptual boundary between episodic knowledge and cultural knowledge and the forced choice design of the study in Chapter 2 may have caused confusion in children's knowledge predictions.

The knowledge prediction heuristic I proposed suggests that children must view a conceptual boundary between episodic and cultural knowledge, due to the difference in information needed to predict which individuals share your knowledge of episodic and cultural knowledge items. If there is evidence that children do not view a conceptual boundary between episodic and cultural knowledge, it may be that there are other variables children use to predict others' knowledge that I have not accounted for, including inferred knowledge access or how widely or narrowly shared a knowledge item typically is. Future research should investigate the process that children predict others' episodic knowledge, specifically to assess differences in how children reason about cultural and episodic knowledge items. For example, studies could examine whether children use information about knowledge access to predict both cultural and episodic knowledge, because I predict that information about knowledge access is required to predict episodic knowledge, but not cultural knowledge. That is, while you need information about someone's access to a specific event or experience (episodic knowledge item) in order to infer that this person 'knows' it, the same is not true of cultural knowledge. You can infer that someone possess cultural knowledge by considering their social group memberships and without any observed evidence of their access to a cultural knowledge item. If children treat information about knowledge access (i.e., being present, being told by a reliable source) as necessary to predict episodic knowledge but not cultural knowledge, this will provide evidence that children do view some form of conceptual boundary between these knowledge types, due to the difference in how children treat and predict them.

Adaptive overestimations of shared cultural knowledge

By virtue of a heuristic being a mental shortcut, use of a heuristic should occasionally lead to knowledge prediction errors. I predicted that if a knowledge item was not shared in the way that this heuristic would predict, children should make predictable and interpretable errors in their estimations of who shares that particular piece of knowledge. I argued that observing these signature limits would provide evidence for the use of this knowledge prediction heuristic, because use of the heuristic should lead to overestimations (e.g., if a cultural knowledge item which is typically shared by members of a social group should not be in this particular context) whereas other strategies would lead to underestimations (e.g., considering knowledge access would lead to underestimations of who shares knowledge due to a lack of information about knowledge access when predicting cultural knowledge items).

Two studies presented in this dissertation investigate overestimations of knowledge, but these studies provide conflicting evidence when examining whether children make these overestimations and then whether these overestimations influence other communicative outcomes (i.e., perspective-taking). Chapter 3 finds that 4-year-olds (but not 6-year-olds) overestimate who shares knowledge of a novel cultural knowledge item, but do not overestimate who shared knowledge of an episodic knowledge item. This finding suggests that young children may be prone to overestimating who shares knowledge of something that is an example of a cultural knowledge item (i.e., songs, dishes, stories, language). This overestimation error specific to cultural knowledge items is predicted by the heuristic I propose, as a quick prediction using a knowledge prediction heuristic would lead children to predict that knowledge of a cultural knowledge item is widely shared among the social group members it is associated with, even if this specific example should not be. That is, considering the type of knowledge and the way that type of knowledge is typically shared can

lead to overestimation errors if a knowledge item is not shared in a way that is typical for that type of knowledge.

I predicted a different overestimation error in Chapter 4. Namely, I predicted that shared social group membership (and subsequent inferred increases in shared cultural knowledge) may lead children to overestimate how similar their visual perspective was to a partner, leading to an increase in perspective-taking errors. That is, I also predicted that considering information about the individual whose knowledge is being predicted may also lead children to make overestimation errors. However, 4- and 6-year-olds in Chapter 4 made no more perspective-taking errors when communicating with a partner from the same social groups (and who should share a bank of cultural knowledge with the participants) than when communicating with a partner from different social groups (and who should not share cultural knowledge with the participants). Research in adults suggests that increases in the amount of shared knowledge between communicative partners leads to increases in perspective-taking errors, perhaps due to a reduced feeling of need to consider a partner's perspective if you believe that you already share a lot of information with that partner (Savitsky et al., 2011; Van Der Wege et al., 2021; Wu & Keysar, 2007). Thus, we predicted that an increase in the amount of shared knowledge would cause children to overestimate which other pieces of knowledge were shared too, causing perspective-taking errors if children assumed that privileged information was instead in common ground. Conversely, we found that shared social group membership with one partner did not lead children to overestimate how similar their perspective was to their partner, meaning that children's perspective-taking performance was unchanged by the amount of shared cultural knowledge.

Why did the studies in Chapter 3 support the idea that children's knowledge prediction heuristic should overestimate shared knowledge when the knowledge type is cultural, yet the studies in Chapter 4 did not support the idea that children would overestimate

shared perspective based on inferring shared cultural knowledge? Because we did not measure children's predictions of shared cultural knowledge with each partner in Chapter 4, it is possible that children did not predict shared cultural knowledge with the partner from the same social groups (similar partner). However, this is unlikely as other evidence suggests that children treat geographic location and accent as strong indicators of group membership (Floccia et al., 2009; Kinzler et al., 2007, 2011; Weatherhead et al., 2016; Weatherhead, Friedman, et al., 2018; Weatherhead, White, et al., 2018), predict that some kinds of knowledge are shared by people who speak the same language (songs; Soley & Aldan, 2020), and children of the same age used geographic location to predict shared cultural knowledge in Chapter 2. Additionally, the similar partner expressed one piece of shared knowledge with participants (shared book or TV show knowledge), meaning that it is very unlikely children did not predict shared cultural knowledge with the similar partner.

There are two additional possibilities which are more likely to have influenced this difference in children's knowledge overestimations. One possibility is that episodic knowledge overestimations (e.g., what someone has visual access to right now) are not influenced by sharing a bank of cultural knowledge. That is, while a heuristic may lead children to overestimate who shares a cultural knowledge item that should not be shared with all group members, increases in one type of shared knowledge (e.g., cultural knowledge) may not cause overestimations of another type of knowledge (e.g., episodic knowledge). In Chapter 4, children could have inferred an increased amount of shared cultural knowledge with one partner, but perspective-taking errors in this task were caused by children overestimating how much episodic knowledge was shared (i.e., episodic knowledge of items that were currently in the grid). Though 4-year-olds may have overestimated how likely an individual was to share novel cultural knowledge in Chapter 3 (as the heuristic would lead children to predict cultural items as being widely shared by group members), the bank of

shared cultural knowledge with the similar partner in Chapter 4 may not have influenced the more episodic knowledge overestimations that we measured as perspective-taking errors. The trend demonstrating a reduction in children's perspective-taking when communicating with a parent or caregiver further supports this hypothesis, as children typically share a bank of prior episodic knowledge with a caregiver (but would not share any prior episodic knowledge with a stranger from the same social groups), perhaps demonstrating that an increase in shared episodic knowledge may lead children to overestimation exactly how much episodic knowledge is shared.

To test this possibility, children could participate in a task which directly measures whether increases in shared episodic knowledge or shared cultural knowledge influence subsequent episodic knowledge predictions. For example, children could be presented with novel shapes and learn either 25% or 75% of the names of these novel shapes with a partner to manipulate increases in shared episodic knowledge through knowledge of novel shape names (as tested in adults by Wu & Keysar, 2007). Then, children could be taught the names of the remaining novel figures alone, and we could measure how often children use these privileged names when subsequently communicating with each partner about the novel shapes. If children demonstrated more overestimation errors when communicating with the partner who shared 75% of the novel shape names, this may suggest that increases in episodic knowledge related to the task may cause subsequent knowledge overestimations in children. However, if there is no observed difference between these two partners, this would provide further evidence that amount of shared knowledge does not appear to influence children's overestimation errors in the same way that it appears to for adults (e.g., Savitsky et al., 2011; Wu & Keysar, 2007).

To investigate whether cultural knowledge influences how often children use the privileged novel shape names, children could learn 50% of the novel names with two

partners, one from the same social groups and one different social groups. We could again measure how often children used the names that only they were aware of during subsequent interactions with each partner, and measure explicit cultural knowledge predictions for each partner. If children do attribute an increase in shared cultural knowledge with the partner from the same social groups and demonstrate more errors with this partner, this would provide evidence that an increase in shared knowledge generally (i.e., knowledge unrelated to the task at hand) could still influence children's overestimation errors. However, if children perform equally for both partners but still attribute an increase in shared cultural knowledge with the similar partner, this would support the idea that an increase in shared knowledge generally does not influence children's other shared knowledge overestimations.

An alternate possibility is that the process of predicting knowledge and interpreting an ambiguous request by considering a partner's perspective are distinct processes in children. This may mean that because we manipulated increases in inferred shared knowledge through children completing a task with a partner from the same or different social groups, their caregiver or a stranger, the changes in shared knowledge with these partners did not affect how children interpreted their ambiguous request. Instead, it is possible that the trend suggesting reduced perspective-taking when communicating with a caregiver was due to feelings of closeness or familiarity, and not shared knowledge. In Chapter 3 however, children made clear knowledge overestimations when they were prompted to consider who shared knowledge of a novel cultural item, but we measured overestimations of prompted and explicit knowledge predictions, rather than responses to an ambiguous instruction. Children may make knowledge overestimations due to use of a knowledge prediction heuristic, but these shared knowledge predictions may simply not affect children's perspective-taking (as shared knowledge appears to in adults; Savitsky et al., 2011; Van Der Wege et al., 2021; Wu & Keysar, 2007). The trend towards children overestimating how similar their perspective

was to their caregiver's perspective provides some evidence against this hypothesis. However, it is still possible that this trend was due to feelings of familiarity and closeness with a caregiver, rather than prior shared episodic knowledge specifically. In order to investigate the role of knowledge overestimations on children's perspective-taking, future research will need to carefully manipulate shared episodic experiences and feelings of closeness with a partner separately. For example, children who are in the same class may have a wealth of shared episodic experiences but may not feel as close to one another (if these students are not friends) as children do to their parents. Children could also participate in an extensive warm up task with one partner but not another, providing an increase in shared episodic knowledge with only one partner, while still not manipulating feelings of closeness. Examining the role of shared knowledge in perspective-taking may help to highlight the cause of this observed difference in children's knowledge overestimations and the effect of such overestimations on communicative outcomes.

Developmental change in children's knowledge predictions

Throughout this dissertation I have examined how children make knowledge predictions between age 3 and age 6, yet there were no significant age differences or trends in Chapter 2 or in Chapter 4. Strikingly, and though we tested children across a four-year age range, there were no detectable developmental differences in the way that 3- to 6-year-olds predicted who should share both their own and novel cultural knowledge (Chapter 2). Additionally, there were no age differences in the way children differentiated cultural knowledge from general knowledge and procedural knowledge. In Chapter 4, neither 4- or 6-year-olds showed a reduction in their consideration of a partner's perspective when communicating with a stranger from the same social groups as themselves, but both 4- and 6-year-olds considered the perspective of their parent or caregiver less than the perspective of a stranger. The consistency in the way children made both explicit knowledge predictions and

inferences about the necessity to consider a partner's perspective suggests that the process children use to consider others' knowledge must have foundations early in development.

Children do not always reason about knowledge in a consistent way from 3- to 6-years. For example, 5-year-olds reject an incorrect knowledge claim (e.g., Saying 'I know where X is', but not being present while X was hidden) but children 4-years and younger do not (Fedra & Schmidt, 2019). 4-year-olds consistently claim that they have always known a novel fact that had just been taught, yet 6-year-olds (and 5-year-olds in some contexts) do not (Taylor et al., 1994). Perhaps most famously, 3-year-olds expect others to have knowledge of an object's location which was switched in their absence, but 4-year-olds do not (Wellman et al., 2001; Wimmer & Perner, 1983). It is possible that these developmental differences in considering others' knowledge do not stem from a change in understanding how knowledge is typically shared with others or an inability to predict the knowledge of others, but rather difficulty restricting which people your knowledge should be shared with through use of other cognitive abilities, like inhibitory control (e.g., Birch & Bloom, 2003, 2004). If an initial prediction generated by a knowledge prediction heuristic leads children to believe that knowledge is more widely shared than it actually is (as in Chapter 3), children will need to inhibit this initial prediction and adjust it using personal experiences and contextual information (e.g., whether this is a typical example of cultural knowledge or episodic knowledge, whether an individual's knowledge set is typical for someone who is a member of their social groups and communities). This may mean that developmental changes in predicting knowledge from 3- to 6-years are at least partially due to developments in inhibitory control across this period (Carlson & Moses, 2001; Diamond & Taylor, 1996; Gerstadt et al., 1994; Macdonald et al., 2014; Nilsen & Graham, 2009), rather than a major development in the process children use to consider the knowledge of others.

If the process children use to predict others' knowledge is present from early in development and becomes more nuanced with increases in other cognitive abilities (i.e., inhibitory control) and social experiences, this would explain the lack of age effects seen in Chapter 2 and Chapter 4. Chapter 2 examined which factors children used to inform their predictions for different knowledge types, and the lack of age effects throughout this chapter suggests that there is consistency in the information and process children use to predict others' knowledge from 3- to 6-years. Chapter 4 also found no age differences when comparing the number of perspective-taking errors for partners varying in amount of shared knowledge with participants, suggesting that the process children use to consider information about their partner and integrate this with their communicate responses must also be reasonably consistent from age 4 to age 6. Together, these results do suggest that the ability to consider others' knowledge through a heuristic emerges at least by age 3, though this process may be refined with experiences or other improved cognitive abilities, like inhibitory control.

When asked to predict who should share knowledge of a novel cultural knowledge item (which was not shared in a way typical for cultural knowledge) 4-year-olds overestimated who would share their cultural knowledge in Chapter 3, but 6-year-olds did not. This error was predicted by the knowledge prediction heuristic I proposed, however, 6-year-olds did not make this overestimation error. If children are using the same heuristic, why did 4-year-olds make this overestimation error when 6-year-olds did not? One hypothesis is that developments in inhibitory control allowed 6-year-olds to inhibit the initial prediction generated by the heuristic, but 4-year-olds did not. If children assume that knowledge of typical cultural items are widely shared among members of the social groups they are associated with, children in Chapter 3 would have needed to inhibit this standard prediction when predicting who should share knowledge of a novel cultural item. Because 6-year-olds

tend to score higher on inhibitory control measures than 4-year-olds (Carlson & Moses, 2001; Diamond & Taylor, 1996; Gerstadt et al., 1994; Macdonald et al., 2014), 6-year-olds may have been better at inhibiting this typical prediction when the piece of cultural knowledge was not shared in a typical way. Replicating these effects and correlating overestimation errors with individual measures of inhibitory control would allow us to examine the effect of inhibitory control on knowledge overestimation errors. As it is possible that other variables are influencing this developmental difference (including age, life experiences, and qualitative changes in heuristic or process), understanding how inhibitory control relates to the likelihood of overestimating shared knowledge would be a first step in disentangling these possibilities.

Interestingly, because I predict that children use a consistent knowledge prediction process from at least 3- to 6-years, adults may be using a similar knowledge prediction heuristic too and simply adjusting it further or by considering more variables given their extended life experiences. If even adults are using a similar knowledge prediction heuristic to assist them in efficiently considering the knowledge of others, you may expect adults to make interpretable overestimation errors similar to the 4-year-olds in Chapter 3 in some circumstances. In situations where use of a heuristic would lead adults to make an initial prediction that is incorrect, adults too may make overestimation errors if they do not adequately inhibit the initial predictions generated by the heuristic. For example, adults may fail to adjust their predictions when they are under time pressure, under a high cognitive load, or even when they are tired. Evidence showing that cognitive load affects adults' communication and consideration of others' perspectives provides initial support for this idea (see Cane et al., 2017; Huttunen et al., 2011; Kjellberg, 2004), alongside research demonstrating predictable episodic knowledge overestimations in adults (Birch & Bloom, 2004; Fischhoff, 1975; Hinds, 1999). Anecdotally, it would not be uncommon for adults to

overestimate who shares a piece of knowledge in a way this heuristic would predict. You may have had experience assuming that an individual did not know something you predicted they would, such as a ‘classic’ movie or a ‘traditional’ dish (which are examples of cultural knowledge and thus typically widely shared among the social groups they are associated with). If adults do occasionally make predictable overestimation errors when considering who shares their cultural knowledge, these errors may also provide evidence that the function of a knowledge prediction heuristic is stable across development and, as we age, we learn to adjust our predictions in a more nuanced manner.

Though there is evidence that children do not rely on experience with a cultural knowledge item to predict how it should be shared with others (Chapter 2), this does not mean that experience does not play a role in children’s knowledge predictions. In Chapter 3, 4-year-olds predicted that a stranger would share knowledge of a novel cultural item, but 6-year-olds did not. One possible explanation for this finding is that 6-year-olds may have experience predicting a more diverse range of knowledge sets than 4-year-olds, due to the increased social experiences children get while attending school. Though a heuristic may provide initial predictions about the way a knowledge item is shared through considering the individual and type of knowledge being predicted, as children gain more experience predicting the knowledge sets of others, these initial predictions may be adjusted using prior experience in order to create a more nuanced prediction process. This idea similar to the ‘anchoring and adjusting’ theory posed by (Nickerson, 1999), who suggests that while we may use an initial heuristic to make efficient knowledge predictions (Nickerson suggests we first attribute all of our own knowledge to others), we subsequently adjust these predictions given information about the context and the individual whose knowledge we are predicting. Though a knowledge prediction heuristic which considers the type of knowledge and the individual whose knowledge is being predicted may provide children with an initial

knowledge prediction, experience predicting the knowledge sets of others may begin to refine children's predictions leading them to create more accurate and nuanced predictions across time.

Knowledge in Communication

Previous literature has highlighted the importance of knowledge predictions during communication, specifically for ensuring efficient but still effective communication of a message or meaning (e.g., Baer & Friedman, 2018; Clark, 1996; Clark & Brennan, 1991; Grice, 1969; Grice, 1975; Isaacs & Clark, 1987). However, much of the research presented in this dissertation examines explicit and prompted knowledge predictions. In Chapter 2 and Chapter 3, we explicitly asked children to tell us their knowledge predictions, thereby removing these knowledge predictions from a typical communicative context. Chapter 4 examined whether unprompted shared knowledge predictions influenced children's perspective-taking in a real time communicative task with a partner. However, the results of this study do not show a clear effect of shared knowledge due to the null results of Study 1 (despite one partner sharing more cultural knowledge with participants) and the confounding of familiarity and closeness with the partner who shared a bank of prior knowledge with participants in Study 2 (Caregiver). Thus, it is difficult to disentangle the role of predicted shared knowledge specifically in during this communicative interaction. Though understanding how children employ their knowledge predictions in communication is important, I felt that it was first important to investigate how children predicted others' knowledge and the constraints of this knowledge prediction process. The findings of the current studies show that 3- to 6-year-old children are capable of selectively predicting others' knowledge when explicitly prompted to consider an individual's knowledge state. However, because of the importance of knowledge predictions during communicative

interactions, further research is needed to understand whether children make similar predictions when they are not prompted to consider an individual's knowledge set.

It is possible that though children do readily consider a partner's knowledge during communicative interactions, even when children are not prompted to consider a partner's knowledge set. Three- and 5-year-olds spontaneously provide more information to a partner who was not present to learn the information than a partner who was present (even when not prompted to consider what their partner knows; Köymen et al., 2016), and 3-year-olds only enforce the rules of a novel game with peers who were present to learn the rules (without any emphasis on whether this peer knows how to play; Wyman et al., 2009). These studies demonstrate that children may change their behaviour or amount of information provided based on an individual's episodic knowledge, even when they are not explicitly prompted to consider this individual's knowledge state. However, children were provided with salient cues to a partner's knowledge state (e.g., being told that a partner was going to leave and having an experimenter explicitly call this partner back once a piece of knowledge had been presented), so it is possible that children may not show such modulations in their communicative interactions when predicting knowledge with less salient or observable cues (e.g., cultural knowledge).

We do know from previous research that children modulate their communication when explicitly provided with information about a person's knowledge state. By age 5, children will provide general and explanatory information when they are explicitly told that a partner that does not know about something (e.g., will explain that cups are for drinking), but will instead provide more specific or unusual information when explicitly told that a partner that knows about something already (e.g., will explain that this cup has polka dots on it; Baer & Friedman, 2018). However, in this study children were not required to predict a partner's knowledge as they were explicitly informed of their partner's knowledge state. Thus, it is still

unclear whether children spontaneously choose to predict a partner's knowledge and use these predictions to adjust their communication.

One study hints that as children develop, they may begin to integrate their spontaneous knowledge predictions and their communicative interactions. Liebel et al., (2013) found that when a stranger used a confused tone to request an item, 3- and 5-year-olds thought that this person was referring to a novel figure (i.e., The Sandman). However, when this person used a tone of recognition to request an item, only 5-year-olds thought that this person was referring to a well-known figure (i.e., Santa Claus). This study provides some evidence that 5-year-olds (but not 3-year-olds) may spontaneously predict that someone from similar social groups share knowledge (i.e., those who speak the same language or are in the same geographic location) and use these spontaneous knowledge predictions to inform their responses to an ambiguous request, even in the absence of observable cues to a partner's knowledge state. Because of the developmental difference in children's responses, this study may suggest that although 3-year-olds appear able to predict others' knowledge (as in Chapter 2), 3-year-olds do not spontaneously use these knowledge predictions to adjust their communication until later in development (5-years-old; Liebal et al., 2013). Importantly, this study uses information that should only be shared by people present during the item's creation (i.e., a novel figure) and an item which is very widely shared across social groups (i.e., a well-known figure, Santa Claus). Thus, while this study provides information that children adjust their communicative responses when considering knowledge that should be shared with almost everyone and knowledge that is very narrowly shared, it does not investigate the nuanced way that children are required to spontaneously consider a specific individual's knowledge set using their social group memberships when predicting cultural knowledge, and subsequently adjust their communication specifically for that individual.

It would be especially interesting to investigate how children spontaneously predict cultural knowledge and integrate these predictions into their communicative interactions. As we are often not prompted to predict others knowledge in the explicit way that children were questioned about others' knowledge in this dissertation, the real-world benefits of predicting others' knowledge (e.g., increases in communication efficiency and effectiveness) relies on children making knowledge predictions spontaneously. There are often no observable cues to a partner's cultural knowledge set so children instead need to consider other cues, such as social group memberships, when predicting cultural knowledge. The lack of observable cues to a partner's knowledge state could feasibly lead children to consider a partner's knowledge *less* than when predicting episodic knowledge (which does often require observable cues to a partner's knowledge to facilitate accurate predictions) or more general knowledge (which is widely shared with most individuals). There is evidence that adults readily predict a partner's cultural knowledge and use it to modulate their communicative interactions (e.g., Clark et al., 1983; Isaacs & Clark, 1987). Thus, investigating whether children spontaneously consider others' cultural knowledge and use it to adjust their subsequent communication will provide information about how predictions from such a heuristic begin to be implemented in communication across early development, and may also highlight one purpose of an early emerging knowledge prediction heuristic (e.g., for understanding and communicating with others).

It is possible that young children may make cultural knowledge predictions because these predictions are important to create effective and efficient communication. That is, a knowledge prediction heuristic exists because it is functional in allowing effective and efficient communication with others. This may mean that from as early as children can predict others' cultural knowledge, children begin to adjust their communication according to their communicative partner's predicted knowledge. An alternate possibility is that young

children may begin by predicting a partner's cultural knowledge and subsequently learn how to integrate these predictions to produce efficient and effective communicative interactions. While young children can predict others' cultural knowledge (as in Chapter 1), children may not yet spontaneously integrate these knowledge predictions into their communication efficiently. Research into how children implement their spontaneous cultural knowledge predictions into communication may help to highlight the order of this development. For example, as 5- and 6-year-olds adjust their communication when explicitly told about a partner's knowledge (Baer & Friedman, 2018), future research could investigate whether children provide more explanatory information to a partner who they predict does not share a piece of cultural knowledge (e.g., Explaining that 'Te Papa' is a museum in New Zealand when speaking with a stranger who lives overseas) and provide more specific pieces of information when children predict a partner does share a piece of cultural knowledge (e.g., Explaining that they visited Te Papa yesterday when speaking with a stranger who lives in the same city). Understanding how children begin to modulate their communicative interactions with unprompted knowledge predictions will highlight the developmental progression of knowledge predictions and integration of these predictions into communication.

Chapter 4 provides some evidence that the amount of shared knowledge between communicative partners may change children's perceived feeling of need to perspective-take. When considering whether children make unprompted knowledge predictions during communication, understanding what influences children's perceived feeling of need to make a knowledge prediction will be important too. It is possible that children default to considering a partner's knowledge state during communication, even if they are not explicitly prompted to do so. For instance, before referring to 'Te Papa' by the museum's proper name, children may always make a quick prediction about whether this individual is likely to know

what ‘Te Papa’ is. However, I predict that it is more likely that variables within the communicative interaction, such as who the partner is or which knowledge is being discussed, may alter how likely children are to actively consider whether a knowledge item is shared by a specific communicative partner. For example, while children might consider whether a stranger knows ‘Te Papa’ before using the proper name to refer to this museum in a conversation, children may be less likely to do this when communicating with their caregiver or a sibling (with whom children have more prior information about their potential knowledge set). Variables that could influence rates of spontaneous knowledge predictions include feelings of closeness or familiarity with a partner, which may lead to children actively predicting a partner’s knowledge *less* (as in adults’ perspective-taking; Savitsky et al., 2011; Van Der Wege et al., 2021; Wu & Keysar, 2007) or prior successful communicative experiences (which may decrease children’s feeling of need to predict knowledge in future communicative settings). Though I did not examine children’s spontaneous knowledge predictions, it will be important to understand which variables affect children’s spontaneous consideration of others’ knowledge when investigating whether children make spontaneous knowledge predictions and how these spontaneous predictions affect communication.

Conclusions

The research presented throughout this dissertation provides support for a knowledge prediction heuristic that children use consistently between 3- and 6-years in order to facilitate efficient predictions of others’ knowledge. Importantly, these studies highlight key variables that children must consider in order to make these predictions, the type of knowledge being predicted and a consideration of the individual whose knowledge children are predicting, and how these variables interact to predict knowledge state. Despite the early use of such a heuristic, personal experience and increases in the effectiveness of other cognitive processes

(i.e., inhibitory control) are likely to help older children to adjust these initial predictions. Though children may occasionally make knowledge prediction errors, I provide evidence that some of these predictable overestimation errors stem from the adaptive use of a mental shortcut to assist children in making efficient knowledge predictions. Though young children may be prone to overestimating who possesses knowledge that is not shared in a typical way, these errors are indicative of an adaptive heuristic and appear to decrease as children age. Interestingly, increases in shared knowledge did not affect how children considered their partner's perspective. However, children's perspective-taking was reduced when communicating with a parent or caregiver, highlighting the role of prior shared episodic knowledge, familiarity, or feelings of closeness on children's perspective-taking. Taken together, these findings provide evidence for the early and consistent use of a knowledge prediction heuristic from 3- to 6-years, which considers the type of knowledge being predicted, how that type of knowledge is typically shared with others, and how characteristics of an individual may be indicative of their knowledge set. Such a knowledge prediction heuristic may facilitate smooth communicative interactions, allowing children to communicate effectively with the diverse social world around them.

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Appendix A. Ethics approval notifications and supporting documentation

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