False Belief Understanding Requires Language Experience, but Its Precursor Abilities Do Not

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Successful interpersonal interactions depend on our ability to understand and predict the knowledge, beliefs, and/or perspective of others (Watson et al., 1999). We engage in this activity on a daily basis, for example, when we wordlessly understand what a family member may be looking for as they ready themselves for work or school (and subsequently inform them of the item's correct location), or when we choose words appropriately when engaging with friends vs. strangers. While indeed ubiquitous in its application, this ability, termed *Theory of Mind* (ToM), develops over the course of childhood and heavily contingent upon language (see Milligan, Astington, & Dack, 2007). In this study, we investigate the impact of variable language experiences on the development of ToM and its socio-cognitive precursors. By doing this, we hope to disentangle age (maturational) and language effects.

1. Background

An integral part of the human experience, *Theory of Mind* has been studied extensively in the last 40 years. These studies have shown that certain perspective-taking abilities, such as understanding others' *visual* perspective or individual preferences seem to develop relatively early in life. However, a richer ability to understand and employ another's *mental* perspective or belief does not fully develop until about age 4 or 5 (Wellman, Cross, & Watson, 2001). This more mature ability is often assessed using *False Belief* (FB) tasks (Wimmer & Perner, 1983) that present a scenario in which children must (1) understand that another's knowledge of the world may be incorrect or different from their own, and (2) make a prediction about that person's behavior based on that knowledge. In the classic "Sally-Anne" task, the child is told a story in which Sally places her prized marble in one location; a second character, Anne, then moves it to a new location. Crucially, Sally does not observe this location change. The child is then asked where Sally will look for her marble upon her return.

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Success on the FB task seems tightly tied to language. For example, FB performance correlates with language development, as has been shown in studies with children with autism (e.g., Baron-Cohen et al., 1985), training studies with typically developing children (Hale & Tager-Flusberg, 2003), and studies of deaf[1] children who may have experienced delays in their exposure to accessible language (e.g., Meristo et al., 2007; Rhys-Jones & Ellis, 2000; Schick et al., 2007). However, given enough time and exposure to language, deaf children who have experienced degraded access to language in their youth, can eventually overcome this deficit in later childhood or adulthood, eventually succeeding on “basic” first-order FB tasks (O’Reilly et al., 2014),[2] though this development is certainly much more protracted than it is for children who have early exposure to an accessible language (signed or spoken).

Eventual, albeit delayed, success does not simply result from more time to observe others’ behavior. Deaf adults *homesigners* who have not learned a language or engaged with signers for any extended period of time because of environmental and/or economic limitations as opposed to any congenital cognitive deficit, consistently struggle with FB tasks despite their lifelong observation of others’ behavior (Gagne & Coppola, 2017). In a minimally-communicative, non-linguistic false belief task specifically designed for this population that engages participants in a game-like activity (Pyers, 2005), these adult homesigners struggled to predict another’s behavior in a FB situation despite having previously experienced the identical FB themselves. Neither years of social experience with others or immediate first-hand experience with a false-belief could support these homesigners’ success on FB.

1.1. Socio-cognitive precursors to False Belief Understanding

Much like a child must learn to crawl, then stand, then walk, and later, to run, ToM exists on a continuum of development that increases in complexity and abstraction, of which FB is just one later developing part. If we unpack the skills required to succeed on a FB task, we can see these precursors in action. A child must understand first that another’s visual perspective may differ from her own (i.e., they didn’t see the same thing), that they cannot know what the child knows, given their different visual (or other sensory) experience, and that the world is dynamic and how it is now is not as it always has been. Each of these components supports the understanding that others could have their own beliefs that differ from the actual state of the world and from the child’s own beliefs. In addition, the child must also understand that belief states, both true and false, will drive behavior (e.g., to look for an object in one location rather than another). While

[1]As is convention, we use a capital “D” to indicate a Deaf individual who uses a shared sign language and who identifies with their local Deaf community, and a lowercase “d” for the larger category of individuals with severe to profound hearing loss who may or may not identify with a Deaf culture or sign language community.

[2] These individuals do seem to continue to struggle with what have been deemed higher-order ToM abilities such as understanding figurative language and sarcasm. These abilities are clearly language-based and are beyond the scope of the current study.

there are many other precursor abilities to false belief (see Wellman & Liu, 2004 for a ToM Scale), we focus our review on just the precursor abilities that may support success on the FB task and pay close attention to the possible roles of language in the development of these abilities.

1.1.1. Perspective taking: Levels 1 and 2

The ability to understand another's visual perspective develops incrementally, over time, starting with the ability to understand *what* someone else can see (Perspective Taking Level 1, *PTL1*). PTL1 is typically mastered quite early in life. While explicit verbal questions "e.g., what does she see?" are not easily answered until the age of 3 years, tests using eyegaze (Luo & Baillargeon, 2007; Sodian et al., 2008) and/or assisting tasks (Moll & Tomasello, 2006) find that infants can show this understanding soon after their first birthday.

Perspective Taking Level 2 (PTL2) captures *how* another person sees an object differently, and typically is acquired after PTL1 (e.g., Masangkay et al., 1974; Flavell et al., 1981). Here, children have to understand that although the overall object is the same, they and another person may see it from different angles, creating a different percept of the same object. Previous studies show that PTL2 abilities develop later in childhood than PTL1 (e.g., Masangkay et al., 1974; Flavell et al., 1981), but may be understood by children as young as 36 months (Moll & Meltzoff, 2011).

Few studies have directly investigated PTL2 abilities in deaf populations. Shield et al. (2016) found that natively-signing deaf children without ASD outperformed natively-signing Deaf children with ASD on a PTL2 task but not on a mental rotation task. This difference in findings illustrates that the problems with PTL2 are associated with appreciating the perspective of other people, not with the ability to envision an object from different angles. Thus, PTL2 has a socio-cognitive component.

Work with deaf homesigning adults has expanded our understanding of the development of PTL2 by highlighting its link to language (Gagne & Coppola, 2017). On PTL2, these homesigners performed statistically similarly to typically hearing individuals with no schooling (i.e., both groups share an education level, but differ in access to a shared language). Even with severely limited language experience, homesigners succeed on PTL2 tasks.

1.1.2. Understanding non-mentalistic representations: False Photograph

One component of understanding a false belief involves monitoring how the current reality changes with time, and understanding that representations of a previous point in time may differ from the current state of affairs. To capture this understanding independent of an understanding of mental states, Zaitchik (1990) developed the *False Photograph* task. Using this task, Zaitchik (1990) found that children's difficulties with FB stem not from the ability to represent an alternative belief, but in the executive function demands of recalling a former state of affairs in the face of a new reality.

Countering this explanation are the findings showing that language-delayed deaf children, adult homesigners, and children with ASD succeed on false photograph tasks, even though they struggle with FB tasks (e.g., Leslie and Thaiss, 1992; Peterson and Siegal, 1998; de Villiers and Pyers, 2001). To reconcile these findings, we might posit a language-based benefit in which children had acquired enough language to reason about the false photograph, but not enough language to support reasoning about false-beliefs. However, an alternative explanation posits a maturational difference: the deaf children and children with ASD were at least 2 years older and the adult homesigners were more than a decade older than typically developing children previously tested on false photographs. In other words, it may not have been a language benefit, but a benefit of merely developing a little longer.

1.1.3. Testing False Beliefs with minimal language: Experiential False Beliefs

False Belief understanding is typically tested in children using tasks such as the Sally-Anne task described above or other tasks that involve verbally telling a child a story (in sign or speech) and, crucially, asking a verbal question such as “Where will Sally look for her marble?” or, in the prototypical “Smarties” task (Hogrefe et al., 1986), “What do you think (x person) will say is in this box?” Both these approaches consistently find that typically developing children can consider another person’s knowledge or belief by about the age of 4 or 5 years. However, the linguistic nature of these tasks means these tasks cannot easily, if at all, be used to test the understanding of individuals who have experienced language delays. While other forms of non-linguistic tasks have been developed, such as picture-completion tasks (e.g., Pyers and Senghas, 2009), these tasks are generally not successful with populations who have little to no experience with literacy conventions, books, or formal education (Coppola, p.c.). An alternative is to instead capitalize on participants’ life experiences observing and engaging with others by creating situations in which they themselves experience a False Belief. Once the false belief is established, the experimental procedure then motivates the participant to correctly predict (via a behavioral, rather than explicitly verbal response) another person’s belief; this approach avoids asking the overt verbal (or signed) question “What will the other person choose?”

1.2. The Current Study

Across studies of ToM that include both FB reasoning and earlier developing milestones it has been difficult to pin down the relationship between language experience and ToM development. Maturational development is often still confounded with additional language experience. Studies with adult homesigners who have very little linguistic input indicate that 25-plus years of maturational time supports success on visual perspective taking tasks and on the false-photograph test. However, adult homesigners nevertheless systematically struggle with False Beliefs. The obvious conclusion seems to be that understanding others’ false-beliefs and acting upon this understanding depends on language, whereas other, earlier-developing abilities can mature normally regardless of the individual's language experience (Gagne and Coppola, 2017).

What remains unclear is whether earlier-developing socio-cognitive abilities also depend on language and/or communicative abilities. It remains possible that their development among adult homesigners was indeed delayed, but that such development was complete by the time of testing. Testing child homesigners who have varied, but still minimal, exposure to signed or spoken language allows us to address the possibility that these precursor abilities to ToM may indeed also depend on language or communicative experience.

1.2.1. Iquitos, Peru: a unique opportunity

Developmental psychologists have often called on language-delayed populations to discern the relationship between language and cognitive abilities. However, they often face a third-variable problem: while relationships between language and cognition are often seen in atypically- developing populations (e.g., individuals with autism), (e.g., Baron-Cohen et al., 1985), these language and social impairments may stem from the same root, making it difficult to infer a causal relationship between language and cognition. On the other hand, children who experience language delays as a result of environmental, rather than cognitive factors, allow us to better investigate the effect of language on cognition. We observe such a case when children are born deaf and live in areas lacking a linguistic community or education interventions to support their language acquisition.

Iquitos is a moderately-sized city in northern Peru located in the Amazon basin. Despite having a large population and modern services, its location beyond the Andes mountains and hinders contact with the rest of Peru, and importantly, with the capital city, Lima. One of our team members, Sara Goico, has worked in Iquitos for a number of years, documenting the life and experiences of deaf children and adults. In 2016, a parents' association that had been established a mere two years earlier facilitated the opening of a deaf school in Iquitos. The majority of students who entered the school had no previous access to a sign language and had been educated in all-hearing mainstream classrooms with little support and little success (Goico, in press).[3]

One way in which this group of children differs from the homesigners studied in Gagne and Coppola (2017) is in the variability of their language exposure. The youth in Iquitos report varying amounts of access to an established language. Some students had no access to Peruvian Sign Language (LSP). Others had minimal access to LSP through interactions from their mainstream classrooms, where they sometimes learned the LSP alphabet or numbers. Others received home visits from the Jehovah's Witnesses, which included one hearing and one

[3] A few high school students had attended a deaf school run by hearing missionaries where they learned Peruvian Sign Language (LSP). During the first year of the new school, hearing teachers were employed and students were not taught LSP. In its second year, deaf teachers were hired from Colombia.

deaf church member. Some children had received only one or two visits from the Jehovah's Witnesses, whereas others had weekly meetings in which they learned basic vocabulary (e.g., mom, dad, grandmother) and church signs (Jesus, God). A small number of high school students had attended the deaf church school for primary school and learned some LSP.

1.2.2. Hypotheses

In the current study, we aim to better define the boundary of the benefit of maturation by working with children who, like the adult homesigners, have had little language exposure, but who also have had much less time to mature cognitively. We tested the children's performance on PTL1 and PTL2, on a false photographs task, and on a minimally verbal experiential false-belief task. We expected to replicate the well-documented effect of language experience on false-belief performance, such that we predicted a positive correlation between age of language exposure and FB and/or a correlation between amount of language exposure and FB.

With respect to the precursor abilities, we hypothesized that given the early emergence of PTL1 among typically developing children, we should see robust performance independent of language ability. Specifically, we should see no correlation between PTL1 and language experience or age of language exposure. We considered current age as a measure of possible maturational effects in the event that PTL1 abilities were developed over a protracted developmental timeline due to the children's lack of very early (0 - 3) language exposure. However, given studies with very young typically developing children, we did not expect to see any correlation between PTL1 and current age.

The literature offers no basis for making a directional prediction about PTL2 or the False Photographs test. If maturation plays a primary role, we should see strong task correlations with age and not language experience. If language plays a role, then we should observe strong positive correlations with our measures of language.

2. Method

2.1. Participants

Thirty-seven deaf children and young adults (16 female, age range 6-22 years, M_{age}13.9y) living in Iquitos, Peru participated in our study. Due to the variation in language abilities among the students, to be conservative, we counted any previous contact with LSP (however minimal) as language contact; therefore the duration of children's previous language experience ranged from 0-16 years (M_{exp}=6.0y).

2.2. Procedure

We conducted our study at the start of the school's second year (2017), testing all students without known congenital cognitive deficits. This offered us the opportunity to investigate the children's socio-cognitive abilities very early in their schooling experience, before they had extensive language experience.

The students were tested at the newly-established school, in a room away from the main classroom, by one of our team members, Sara Goico, who was familiar to all of the students. To reduce fatigue and to ensure better procedural control, tasks were conducted in turn across all children, over a series of three days. That is, all children available on Day 1 were tested on PTL1 and PTL2, then all children available on Day 2 were tested on False Photograph, and finally on Day 3 on the Experiential False Belief. This ensured that the children never spent more than about 20 minutes at a time away from the classroom, though it also meant that some children were not present for some of the tasks.

2.3. Tasks

2.3.1. Level 1 Visual Perspective Taking (PTL1)

In the PTL1 task (adapted from Gagne and Coppola, 2017), the experimenter presented the child with two images and asked the child to name them, in order to familiarize the child with the images and elicit a common name for each. This step was necessary because most of the children had not been previously exposed to any shared sign system and the experimenter could not expect the child to know the Peruvian sign for all the objects. The experimenter then placed the images back-to-back such that one image faced the experimenter and the other faced the participant. The experimenter then asked "What do *you* see?" and "What do *I* [the experimenter] see?". The procedure was repeated for were five trials using five different pairs of images of locally familiar objects (cat/apple, hat/phone, soda/baby, hat/fish, and ice cream/toilet paper). Both perspective questions were asked for each pair of images, and each pair was flipped so that the child eventually saw every image. If needed, feedback or a repetition of instruction was provided during the first pair of images. The test trials were the trials that asked about the *experimenter's* perspective and were scored as correct if the child correctly identified the image that the experimenter (but not the child) could see when gesturally asked "What do *I* [the experimenter] see?" Though we had allowed the possibility for feedback during the first (cat/apple) trial if needed, no child needed extra help on this first trial, so all trials were included totaling 10 possible correct answers.

2.3.2. Level 2 Visual Perspective Taking (PTL2)

In the PTL2 task (adapted from Gagne and Coppola, 2017; Shield et al., 2016), participants were seated across a table from the experimenter with a lazy susan between them. The experimenter placed an object with an inherent front/back on the lazy susan, and gave the participant a laminated sheet displaying four images each representing the object in one of four orientations (0, 90, 180, 270 degrees). The experimenter then rotated the lazy susan to position the object in one of the four orientations. Front/ back perspectives (0, 180 degrees) were tested first first, then left/right (90, 270 degrees). The experimenter asked, using familiar gestures, "What do you see" and "What do *I* [the experimenter] see?" The participants were encouraged to indicate on the laminated sheet the image that matched their own perspective and the image that they believed matched the experimenter's perspective. Feedback was provided during the first trial as needed. There were four test (experimenter view) trials per object, totaling twelve test trials. A trial was scored as correct if the child could accurately point to the image on the laminated sheet that matched the experimenter's view during the test trials.

2.3.3. False Photograph

The False Photograph task was conducted as reported in Gagne and Coppola (2017), who modeled their task after the Identity-Change Photograph task (Leslie & Thaiss, 1992). Participants were shown a Fujifilm Instax Mini 25 camera, which is similar to a classic Polaroid camera in that prints develop quickly on the spot, and three objects: a plush elephant, a teacup, and a toy car. All participants were first asked to name the three objects. This was to familiarize the experimenter with the specific gesture used by each child for each object, since these labels could vary across children.

The task started with a control question: the elephant was placed on a table and a picture was taken. The developing photograph was placed face-down and the child was asked in gesture what the photograph would display. All participants correctly stated that the image would be that of the elephant. Then the test trial began: the elephant was replaced by the teacup and another photograph was taken. The developing picture was again placed face-down. Before asking about the new photograph, however, the experimenter replaced the teacup with a toy racecar and the child was then asked what object would appear on the face-down photo image (the correct answer being the teacup). Each child received only one test trial for a maximum score of 1.

2.3.4. False-Belief Understanding: An experiential task

We employed an *Experiential* False Belief task developed by Pyers (2005) and fully described in Gagne & Coppola (2017). We therefore summarize the procedure here.

In this task, participants first *experienced* two false beliefs and made mistakes based on those false beliefs before interacting with a trained confederate in a *prediction* game in which the participants had to predict what the confederate would do when experiencing the same false beliefs. Would the participants predict that the confederate would make the same mistake, illustrating that they recognize the confederate's false belief? Or would participants fail to understand that the confederate would have a false belief and thus predict that the confederate would avoid the mistake? The key false-belief trials were an appearance reality trial where a plate of cookies was really fake cookies, and an unexpected contents trial where a pencil box contained a key. After the false belief trials, we administered two memory trials to ensure that the participant remembered which plate of cookies was fake and that there was a key in the pencil box.

Preceding the key false-belief trials, the participant makes predictions on familiarization and control trials that emphasize key features of the task: (1) successful predictions are rewarded (cookies for the current study) and (2) people have individual preferences that you can't accurately predict.

Before the confederate selected their own response, participants indicated their prediction of the object that the confederate would choose by circling the object on a laminated sheet displaying the possible responses. The experimenter encouraged the participant's response by pointing to the confederate, to the laminated sheet, and making inquiring gestures/ looks.

2.4. Results

2.4.1. Visual Perspective Taking

Of the larger pool of 37 children, 36 participated in the two perspective taking tasks (M_{age}=14.16 years, range 6-22 years; Years of exposure: M_{exp}=6.22 years, range 0-16 years).

2.4.2. PTL1

Perspective Taking Level 1 scores ranged from .4 to 1 (M_{PTL1}=.89, SD_{PTL1}=.164) and were uncorrelated with participants' current age (r=-0.0847, p=.620), age at first language exposure (r=0.0528, p=.758), and number of years of language experience (r=-0.0948, p=.579; Fig. 1). This is mainly due to ceiling effects; even the youngest participants with minimal language experience succeeded.

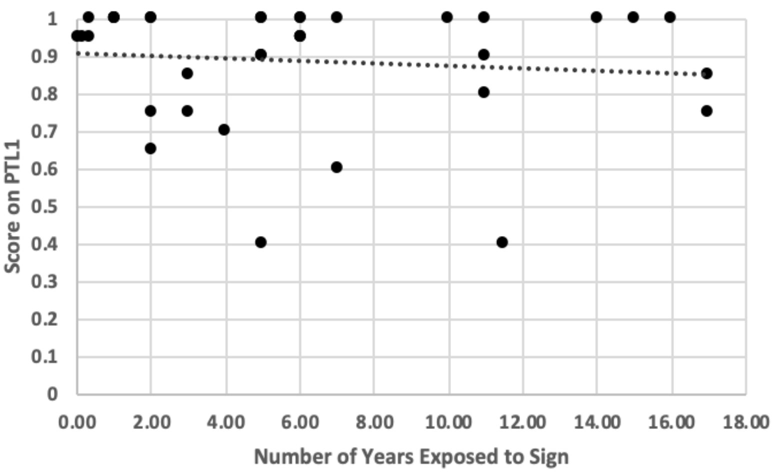

Figure 1. Participants with varying durations of language exposure succeeded at PTL1; there was no correlation between PTL1 scores and their years of language experience.

2.4.3. PTL2

PTL2 scores ranged from .08 to 1 (M_{PTL2}=.79, SD_{PTL2}=.215). Surprisingly, we found that PTL2 scores were significantly correlated with the participants' current age (r=0.441, p=.007; Fig. 2), but not with their age of reported first language exposure (r=-0.065, p=.706), or years of language experience (r=0.287, p=.089). The positive effect of age, something not previously observed with adult homesigners. (Gagne & Coppola, 2017).

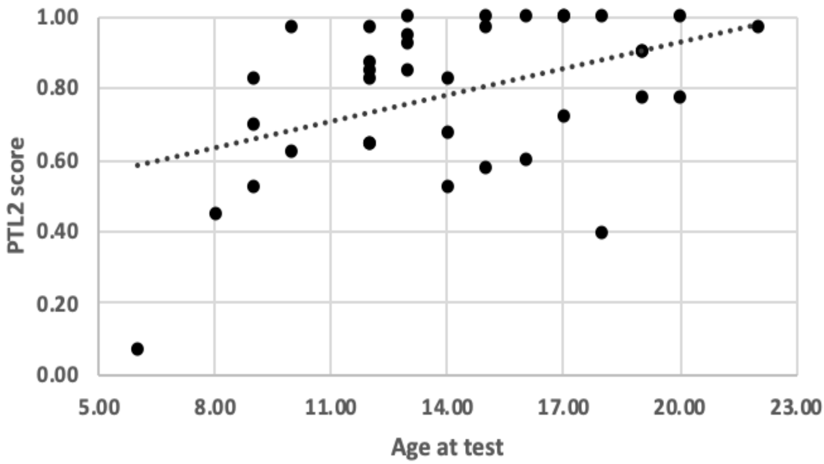

Figure 2. Participants' current age significantly predicted PTL2 scores.

2.4.4. False Photograph

Three children did not complete the False Photograph test because of absences from school. The 34 participants ranged in age from 6-22 years, M_{age}=14.26 years and had on average 6.44 years of language exposure (range 0-16 years). We excluded one child due to a miscommunication with the experimenter during the practice question/ familiarization question.

Strikingly, almost all of the participants (32/33) correctly responded to both the familiarization (elephant) question as well as to the test question that the concealed photo would display the teacup in spite of the fact that the car was currently physically present. The one child who did not succeed responded correctly to the familiarization question but responded incorrectly that the second photo would display a car. This near-uniform ceiling performance indicates that age and language exposure play little role in the development of the ability to recall information that conflicts with one's current reality. Further, development appears to follow a similar maturational timetable as observed in typically hearing children (though we cannot confirm this with the current data).

2.4.5. Experiential False Belief

Thirty-six of the 37 children were tested using the experiential False Belief task; one child was absent the day of FB testing (Age range = 6-22, M_{age}= 13.97 y; Years of language = 0-17 years, M_{exp}=5.84 y).

Nine participants did not predict correctly in one or both of the control trials described above[4] and were excluded. The remaining 27 children earned a FB score of 0, 1, or 2 for their correct responses to neither, one, or both FB trials. We found no significant correlation between participants' scores and their current age (r_s= -0.038, p=0.850)[5], age of first language exposure (r_s=-0.218, p=0.273), or duration of language experience (r_s=0.143, p=0.472) (Fig. 3).

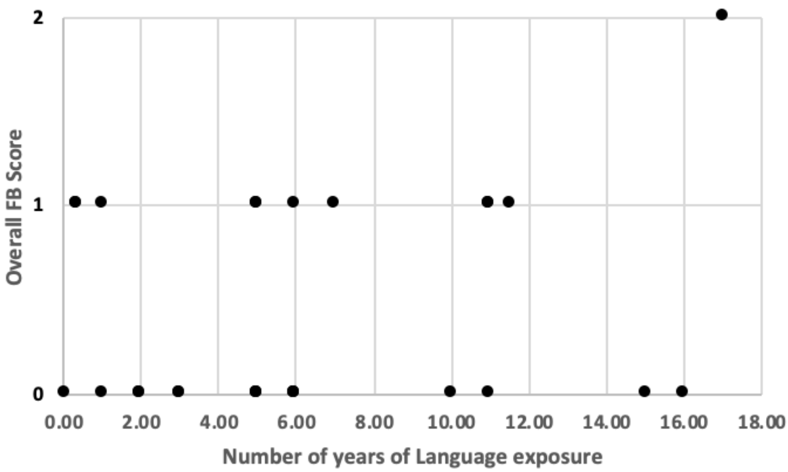

Figure 3. Duration of language exposure did not predict overall False Belief score.

3. Discussion

The goal of our study was to investigate the effects of maturation and language on earlier developing ToM abilities that may support false belief understanding. By investigating these abilities in a group of young homesigners, we hoped to be able to disentangle these effects. Using several tasks investigating false-belief understanding and its precursors to false we found that: (1) the ability to understand *what* someone else may see (PTL1) is mastered by age six, regardless of language experience, (2) the ability to understand *how* someone sees the same object from a different angle (PTL2) may develop later in the absence

[4] Four children answered incorrectly in Appearance/Reality only, 3 in Unexpected Contents only, and 2 made incorrect predictions for both check questions.

[5] While Pearson's correlations were used for the Perspective Taking scores (a continuous measure based on proportion correct), Spearman's Rank Correlation Coefficients were calculated for the FB tasks due to the ordinal nature of the scores.

of typical language input, and (3) the ability to recall previous instantiations of the world and compare them to the present (False Photograph) is likely founded in maturation and mastered by the age of 6 regardless of language experience. In general, we observed relatively strong performance on PTL1, PTL2, and false photographs, with strikingly weaker performance on the false-belief measure, similar to the pattern of results observed in adult homesigners (Gagne and Coppola, 2017). While we cannot say conclusively with this sample that these early milestones arise early in all in deaf populations with limited language, we can say that performance on this task is unrelated to our measures of language experience. As such, we speculate that given this pattern of results, we might see similar developmental timelines as is observed in typically developing children (e.g., Masangkay et al.,1974)[6].

We had two surprising findings. First, PTL2 performance was correlated with age, not language experience, indicating that this development may be more protracted and shaped by social experiences beyond language. Second, the variable performance on the FB test did not correlate with either of our measures of language experience. We suspect that in both cases, the non-effect of language arises as a function of our liberal operationalization of language experience. For example, some children who report many years since their first sign lesson likely still experienced significantly degraded language input as compared to a typically developing child. Thus, future research would benefit from a more systematic means of capturing language abilities in these young homesigners.

While we found no correlation between FB scores and age, years of language exposure, or age at which they had first been exposed to sign, we do note one interesting difference between the current results and previous work. Adult homesigners consistently responded incorrectly to both FB trials (Gagne and Coppola, 2017). However, several of the Peruvian youth passed one, but not the other, of the FB test predictions, including the youngest, a six-year-old who had only just begun signing four months prior. Overall, the Peruvian youth performed more like signers from the first cohort of Nicaraguan Sign Language (Gagne and Coppola, 2017; Pyers and Senghas, 2009; Pyers, 2005). The budding language experience that these Peruvian children have been getting in the social context of school may be helping some them to begin to consider others' beliefs and knowledge. However, they may not yet be able to apply that ability consistently. This reinforces previous suggestions that even minimal language experiences may support some aspects theory of mind development. This finding could be capitalized upon even in developed countries like the United States, where children may still experience language delays due to difficulties receiving fully accessible language models.

[6] In most cases, we would suggest further testing to explore the possibility of language effects in children 3-6 years old. However, we recognize that the chances of finding a population such as the children in Iquitos who have had such little language exposure with no oral/aural intervention is rare and is therefore (appropriately) unlikely.

Our current dataset is underpowered to detect relationships among all of the background, language, and cognitive variables. The pattern of results nevertheless aligns with a pattern of theory of mind development showing earlier success on visual perspective taking and false photographs tasks than on false belief tasks.

The opportunity to study the children in Iquitos is profound. Unlike in Nicaragua, where NSL emerged from a collection of homesign systems at the school for the deaf (Senghas et al., 2005), the children in Iquitos now interact with teachers via an established, widely used sign language. Future research should measure the gains that the children are making now that they are in a full-time signing school with peers. We predict that the children in Iquitos will soon be able to master first-order FB tasks but may continue to struggle with higher-order ToM abilities, as found in previous studies with deaf individuals who receive "late" exposure to a first language (e.g., O'Reilly et al., 2014).

References

Baron-Cohen, Simon, Leslie, Alan M., & Frith, Uta. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37-46.

de Villiers, Peter, & de Villiers, Jill. (2012). Deception dissociates from false belief reasoning in deaf children: Implications for the implicit versus explicit theory of mind distinction. *British Journal of Developmental Psychology, 30*(1), 180-209.

de Villiers, Peter, & Pyers, Jennie. (2001). Complementation and false-belief representation. In *Research in Child Language Acquisition: Proceedings of the 8th Conference of the International Association for the Study of Child Language,* pp. 984-1005. Cascadilla Press, Somerville, MA.

Flavell, John H., Everett, Barbara A., Croft, Karen, & Flavell, Eleanor R. (1981). Young children's knowledge about visual perception: Further evidence for the level 1–Level 2 distinction**.** *Developmental Psychology, 17*(1), 99-103.

Gagne, Deanna L., & Coppola, Marie. (2017). Visible social interactions do not support the development of false belief understanding in the absence of linguistic input: Evidence from deaf adult homesigners. *Frontiers in Psychology*, 8, 837.

Goico, Sara A. (2011). A Study of Talk-in-Interaction between a Deaf and Hearing Student in an Inclusion Classroom in Iquitos, Peru. Master's thesis, UC San Diego.

Hale, Courtney M., & Tager-Flusberg, Helen. (2003). The influence of language on theory of mind: A training study. *Developmental Science, 6*(3), 346-359.

Hogrefe, G-Juergen, Wimmer, Heinz, & Perner, Josef. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development* 567-582.

Leslie, Alan M., & Thaiss, Laila. (1992). Domain specificity in conceptual development: Neuropsychological evidence from autism. *Cognition*, *43*(3), 225-251.

Luo, Yuyan, & Baillargeon, Renee. (2007). Do 12.5-month-old infants consider what objects others can see when interpreting their actions? *Cognition, 105*(3), 489-512.

Masangkay, Zenaida S., McCloskey, Kathleen A., McIntryre, Curtis W., Sims-Knight, Judith, Vaughn, Brian E., & Flavell, John H. (1974). The early development of inferences about the visual percepts of others. *Child Development*, 357-366.

Meristo, Marek, Falkman, Kerstin W., Hjelmquist, Erland, Tedoldi, Mariantonia, Surian, Luca, & Siegal, Michael. (2007). Language access and theory of mind reasoning: Evidence from deaf children in bilingual and oralist environments. *Developmental Psychology, 43*(5), 1156-1169.

Moll, Heinrike, & Meltzoff, Andrew N. (2011). How does it look? Level 2 perspective-taking at 36 months of age. *Child Development*, *82*(2), 661-673.

Moll, Heinrike, & Tomasello, Michael. (2006). Level 1 perspective-taking at 24 months of age. *British Journal of Developmental Psychology, 24*(3), 603-613.

O'Reilly, Karin, Peterson, Candida C., & Wellman, Henry M. (2014). Sarcasm and advanced theory of mind understanding in children and adults with prelingual deafness. *Developmental Psychology, 50*(7), 1862.

Peterson, Candida C., & Siegal, Michael. (1998). Changing focus on the representational mind: Deaf, autistic and normal children's concepts of false photos, false drawings and false beliefs. *British Journal of Developmental Psychology*, *16*(3), 301-320.

Pyers, Jennie E. (2005). The relationship between language and false-belief understanding: Evidence from learners of an emerging sign language in Nicaragua. Doctoral Dissertation, UC - Berkeley.

Pyers, Jennie E., & Senghas, Ann. (2009). Language promotes false-belief understanding: Evidence from learners of a new sign language. *Psychological Sci., 20*(7), 805- 812.

Rhys-Jones, Sara L., & Ellis, Hayden D. (2000). Theory of mind: Deaf and hearing children's comprehension of picture stories and judgments of social situations. *Journal of Deaf Studies and Deaf Education, 5*(3), 248-265.

Schick, Brenda, De Villiers, Peter, De Villiers, Jill, & Hoffmeister, Robert. (2007). Language and theory of mind: A study of deaf children. *Child Development, 78*(2), 376-396.

Senghas, Richard J., Senghas, Ann, & Pyers, Jennie. (2005). The emergence of NSL: Questions of development, acquisition, and evolution. In *Biology and knowledge revisited* (pp. 287-306). Mahwah, NJ: Erlbaum.

Shield, Aaron, Pyers, Jennie, Martin, Amber, & Tager-Flusberg, Helen. (2016). Relations between language and cognition in native-signing children with autism spectrum disorder. *Autism Research*, *9*(12), 1304-1315.

Sodian, Beate, & Thoermer, Claudia. (2008). Precursors to a theory of mind in infancy: Perspectives for research on autism. *The Quarterly Journal of Experimental Psychology, 61*(1), 27-39.

Wellman, Henry M., & Liu, David. (2004). Scaling of theory-of-mind tasks. *Child Development, 75(*2), 523-541.

Zaitchik, Deborah. (1990). When representations conflict with reality: The preschooler's problem with false beliefs and “false” photographs. *Cognition*, *35*(1), 41-68.

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