Who Can You Trust? A Closer Look at Preschoolers' Developing Sensitivity to Epistemic Expressions

Tomoko Matsui[1], Taeko Yamamoto[2] and Peter McCagg[1]
[1]International Christian University, [2] Kyorin University

One of the more persistent questions in recent theory of mind research has been just when do children become able to competently assess the evidential quality of the information they are exposed to. Many deeply interesting experiments using both linguistic and non-linguistic tasks designed to help answer this question are discussed in the theory of mind literature. Results of some studies using non-linguistic tasks, for example, have shown that 3- and 4-year-old children generally understand that a person who has seen inside a container will have knowledge about the contents, whereas a person who has merely touched but not seen into the container, will not have such knowledge (Pillow 1989; Pratt and Bryant 1990). Such results suggest that, in the absence of any verbal communication, 3-year-olds appear to understand that seeing provides different information than touching does. Other studies, however, also suggest that children's ability to verbally report sources of information may develop more slowly. O'Neill and Gopnik (1991), for example, tested whether preschoolers could identify an object that was hidden in a tunnel by touching it, by seeing it, or by being told what the object was by the experimenter. When they were later asked how they came to know what was inside the tunnel, 3-year-olds generally failed to explain how they knew, despite being able to identify the object itself.

There seems to be general consensus that being able to explicitly represent and monitor sources of belief is prerequisite to having explicit understanding of belief formation and evaluation of belief as end-product (e.g., Gopnik & Graf 1988). In Dienes & Perner's terms, if one has conscious access to one's own beliefs and can reflect on and verbalize them, those beliefs can be considered as 'explicit knowledge' (Dienes & Perner 1999). Typically, such explicit knowledge is contrasted with 'implicit knowledge,' which is characterized as being inaccessible to consciousness, or being procedural (Karmiloff-Smith 1992). Clearly, one of the most central issues of theory of mind research has been to determine when children acquire explicit understanding of beliefs, for which false-belief tests have played an essential role. By contrast, the question of how and when implicit understanding of beliefs develops has been neglected until quite recently (see Ruffman 2000).

For researchers who are interested in communication, however, implicit, procedural, understanding of speaker's intentions has always been an important issue for both theoretical and developmental investigation (Carpenter et al. 1998; Sperber & Wilson 1995; Tomasello 2000). Verbal communication is generally acknowledged to be a highly unreliable source of knowledge, and a mechanism to deal with testimony (by checking coherence and evidential quality, for example) would appear to be a necessary element in our cognitive system (Perner 1991; Sperber 1996).

Recent studies on children's suggestibility and ability to assess speaker reliability may provide new evidence for involvement of implicit understanding. They have shown that children who do not appear to have explicit understanding of belief nonetheless are capable of deciding who to believe and who not to believe at the time of input (Koenig et al. to appear; Sabbagh & Baldwin 2001; Robinson & Whitcombe 2003; Whitcombe & Robinson 2000). Those studies indicate that 3-year-olds are capable of utilizing both non-linguistic (e.g. plausibility of content of previous utterances, accessibility to evidence, etc.) and linguistic clues to distinguish reliable speakers from unreliable ones. This, in turn, suggests that some, possibly implicit, understanding of speakers' epistemic states develops before explicit understanding of false-belief. Clearly, we need more evidence to confirm or disconfirm this possibility. In the current study, we attempt to investigate the issue, focusing on how young children who typically fail the standard false-belief tasks can make use of linguistic clues to assess a speaker's epistemic stance.

The principal aim of our investigation is to look more closely at how children's spontaneous, or on-line, understanding of linguistically encoded speaker reliability and sources of information in deciding who to believe or what to accept as true information develops between the ages of three and seven. The choice of on-line experimental tasks was also based on our more general assumption that children's sensitivity to linguistically encoded speaker reliability develops as part of their competence in utterance interpretation, which typically involves fast, spontaneous, unconscious, and as such, probably domain-specific, processing (Sperber & Wilson 1995, 2002). Thus, our current study can be seen as an investigation of children's developing competency in communication, which provides an ideal testing ground for investigating interaction between their general understanding of others' mental states and their ability to understand and use linguistic codes as tools to help them understand what is going on in others' minds.

1. Encoding Speaker Certainty and Evidentiality in Japanese

For the research reported on here, we selected four contrasting pairs of Japanese linguistic forms to examine; two sets of sentence-final particles, and two sets of mental state verbs. They are (1) the sentence final particles of speaker certainty *yo* and uncertainty *kana*; (2) the sentence final particle of direct speaker knowledge *yo* and the sentence final particle of hearsay *tte*; (3) the verbs of certainty *know* (*shitteru*) and uncertainty *think (omou*); and (4) the verbs of direct knowledge *see* (*miru*) and of hearsay *hear that (kiku*). (See Figure 1.)

Figure 1: Contrasted linguistic forms

	Contrastive Pairs	Linguistic Form	Epistemic Modality
Contrast 1	*yo* vs. *kana*	particles	speaker certainty
Contrast 2	*yo* vs. *tte*	particles	evidentiality
Contrast 3	*know* vs. *think*	predicates	speaker certainty
Contrast 4	*see* vs. *hear*	predicates	evidentiality

The first item in each contrastive pair is the relatively higher certainty (or more direct evidence) marker, and the second item is the relatively lower certainty (or more indirect evidence) marker. The contrastive pairs also fall into two categories: a speaker (un)certainty category, and an evidentiality category. In each category, the contrast is encoded once in the sentence-final particles, and once in the verbs.

Generally speaking, Japanese sentence-final particles occur with far greater frequency in adult speech than do any individual verb forms. Evidence from the JCHAT corpus—a limited corpus of Japanese mother-child exchanges (Miyata 2000)—suggests that the input frequency of these forms available to young children closely mirrors the frequency patterns in adult Japanese speech. (Table 1 presents data from the one extensive set of available JCHAT corpus, the “Tai corpus”.)

Table 1: Number of certainty and evidentiality markers in the Tai corpus

			Child	Mother
Certainty	verb	*shitteru (know)*	34	70
		omou (think)	12	51
	particle	*yo*	3317	3955
		kana	145	970
Evidentiality	verb	*miru (see)*	109	410
		kiku (hear)	6	34
	particle	*tte*	270	1603

2. The Study

2.1. Hypotheses

Our hypotheses are as follows:

1. The ability to make correct choices based on information about speaker certainty and evidentiality when that information is encoded in sentence-final particles will develop earlier than when the relevant information is encoded in predicates.
2. The ability to make correct choices based on being able to distinguish degrees of speaker certainty will develop earlier than the ability to do so based on evaluation of the quality of evidence the speaker has for making his or her assertions.
3. Performances on the hidden object tasks—tasks that require at least some comprehension of other's mental states—will correlate positively with performances on standard false-belief tests.

2.2. Participants

A total of ninety-seven normally developing Japanese-speaking children—twenty-five 3-year-olds and twenty-four each in the age groups 4, 5 and 6—participated in this study. Mean ages for each group were 3;06, 4;06, 5;05, and 6;05 respectively. There were approximately the same numbers of boys and girls in each group. All participants were recruited from nursery schools and kindergartens in a west Tokyo city with a primarily middle-class population.

2.3. Stimuli

We generated a set of eight utterance types using the seven forms introduced in Figure 1 above. *Yo* serves both as a speaker certainty marker (in contrast with *kana*) and as a marker of better evidence (in contrast with *tte*). The eight utterance types were organized into four contrasting pairs of utterances as illustrated in Figure 2.

Figure 2: Illustrative stimulus utterance examples

	higher certainty/evidentiality	lower certainty/evidentiality
1	The apple is in the red box ***dayo***.	The apple is in the blue box ***kana***.
2	**I know** the car is in is the pink box.	**I think** the car is in is the green box.
3	The hat is in the blue box ***dayo***	The hat is in is the pink box ***datte***.
4	I **saw** it. The socks are in the red box.	I **heard that** the socks are in the orange box.

All stimuli were presented on a laptop computer screen by animated characters created for the experiment. Thus, all participants were presented with the same stimuli in terms of the sound quality, volume, speed, and intonation contours, as well as visual information communicated by facial expressions and other non-verbal gestures.

2.4. Procedure

All data collection activities were conducted in a playroom designed to put children at ease. Participants were tested individually and each session was videotaped with two cameras—one focused on the child, and one focused on the main experimenter. The children's task was to indicate the location of hidden objects based on the animated scenes they witnessed and the verbal clues they received. For each hidden object (each trial), the participants heard two conflicting statements using one of the four pairs of contrasting terms under investigation. The objects—typical food items, articles of clothing and toys—were all familiar to the children.

Following a practice run to familiarize participants with the nature of the game, two sets of tasks were presented to each child. Each set contained eight trials which were further divided into blocks of four trials each—one for each of the four contrasting pairs. After the first eight tasks (two blocks), the procedure was interrupted to administer a version of the "Sally Anne" false belief test and a version of the "Smarties" false belief test. In these now widely-known tests, the overall standard procedures were followed. The contrastive pairs in each block of trials were presented to the participants in a counterbalanced order to offset potential fatigue and practice effects. All other experimental design variables (colors of containers, pairs of colors of containers, number of times correct answer was provided by each animal, position of the animal providing the correct answer, position of the colored containers, color of the correct answer, order of presentation of correct answer, order of the modality contrasts tested, and the order of the trials) were also randomized.

Each individual trial consisted of two parts and began with the child watching a thief surreptitiously hide four different objects in one of two containers. Once all four objects had been hidden, the thief exited the scene. Before the actual testing of the contrastive expressions began, the experimenter reminded the child that she (or he) would now hear some animals talk about the location of the toys and that the child should listen to them carefully to find out where the objects were hidden. In the testing itself, the experimenter addressed each animal in turn, asking if it knew where the object had been hidden. The animals then proceeded to make conflicting statements about the location of the toy. For each hidden object, one of the animal helpers indicated that the toy is in the red (or other color) container using one of the contrasting terms (e.g., *dayo* (certainty)) while the other animal helper indicated that the toy is in the blue (or other color) container using the other of the contrasting terms (e.g., *kana* (uncertainty)). The animated animals shown on the screen were activated when the experimenter placed the cursor on the animal using the computer touch pad. After listening to the two statements from the animals, the child was asked by the experimenter to indicate the box in which the toy was hidden.

Procedurally, the second block of four trials was identical to the first. The animated thief and the hidden objects, though were different, as were the nature (shape and color) of the containers. As stated earlier, all experimental design variables were counterbalanced. By conducting two, two-part trials, each consisting of four contrast tests for a total of 16 different decisions, each child had a chance to respond to each of the contrastive pairs four times. A perfect score for each contrastive pair then was four—one point for each correct decision based on that contrastive pair.

The entire experimental procedure, including greetings, warm-up activities, and the false belief tests required approximately 30 minutes per child.

2.5. Results and Discussion

Table 2 presents the mean scores and statistically significant differences in performances on the four contrasts within each age group. In each age group, performances on the certainty particle tasks were significantly better than performances on the evidentiality verb tasks, and all age groups performed significantly worse on the evidentiality verb tasks than on at least one other task.

Table 2: Contrastive pair test mean scores and within group differences

Age Group	Certainty		Evidentiality	
	Particles *yo-kana*	Verbs *know-think*	Particles *yo-tte*	Verbs *see-hear that*
6-year-olds	3.5*	3.3	3.3	2.8*
5-year-olds	3.3**[i]	3.2**[ii]	2.8	2.2**[i,ii]
4-year-olds	3.3***	2.9	2.5	2.1***
3-year-olds	3*[i]**[ii]	2.2*[i]	2.5	2.1**[ii]

***Significant at the p<.05 level. **Significant at the p<.01 level. ***Significant at the p<.001 level.**

To look for differences across age groups one-way test of ANOVA was conducted on each contrast with age as the independent variable, and a main effect was observed with the certainty verb pair and evidentiality verb pair contrasts (F=6.13, p<.01; F=2.84, p<.05), but not for the certainty particle or evidentiality particle pair contrasts. A Kruskal Wallis non-parametric test (for groups of different sizes) conducted on each contrast with age as group variable also revealed significant differences among age groups for the certainty verb pair (p<.001) and the evidentiality verb pair (p<.05) contrasts. It also revealed significant differences among age groups for the evidentiality particle pair (p<.05) contrasts. No significant difference across age groups was found for the certainty particle pair contrasts.

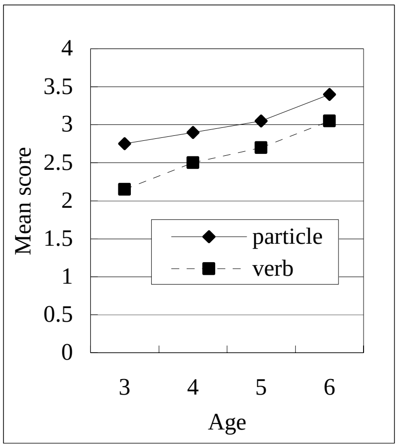
Performances by the three year-olds suggest that they have some ability to make use of information encoded in the particles *yo* (certainty) and *kana* (uncertainty), but their ability to use information about speaker certainty or the source of evidence provided via the predicates *know* and *think*, or *see* and *hear that* to make reasonable decisions is more a matter of chance than competence.

To allow us to address Hypothesis 1 and consider linguistic form as a factor, we categorized the sentence particles and the verbs separately; to allow us to address Hypothesis 2 and consider differences in performances by epistemic modality, we combined results for the speaker certainty contrasts (*yo-kana* and *know-think*) and the evidentiality contrasts (*yo-tte* and *see-hear that*).

Linguistic form

Figure 3 shows that children in all age groups performed better on the particle pairs than on the verb pairs. A one-way test of ANOVA conducted on each age group's performances with linguistic form as the independent variable revealed that the 3-year-olds performed significantly better on the particle pairs than on the predicate pairs ($F=9.123$, $p<.05$).

Figure 3: Effect of linguistic form



The statistics that compared performances across age groups further revealed that with respect to the effect of linguistic form (sentence final particles and verbs), 3-year olds performed significantly lower than 5- and 6-year-olds ($p<.05$ and $p<.001$ respectively), and 4-year-olds performed significantly lower than 6-year-olds ($p<.05$) when speaker certainty or evidentiality were encoded in the verbs. When the epistemic modalities were encoded in the sentence final particles, the 3-year-olds performed significantly lower than the 6-year-olds (p<.05), but no other significant differences were observed.

Figures 4 and 5 show performances on verb pairs (Figure 4) and on particle pairs (Figure 5) by age group. Figure 4 shows that the performances on the two verb pairs by 3-year-olds are at chance level; the 3-year-old children performed similarly poorly on both the speaker certainty verb pair and of the evidentiality verb pair contrasts, but while the performance on the speaker certainty verb pair shows improvement at age 4, no substantial improvement seems to occur for the understanding of the evidentiality verb pair until age 6. T-tests reveal significant differences between the performances on the two verb pairs for 4-year-olds (t=3.045; p<.01) and 5-year-olds (t=3.498; p<.001).

Figure 4: Comparison of verb pairs

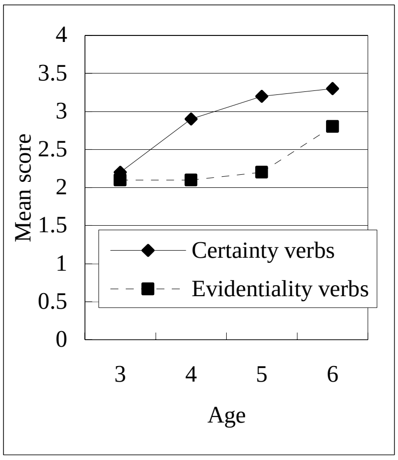
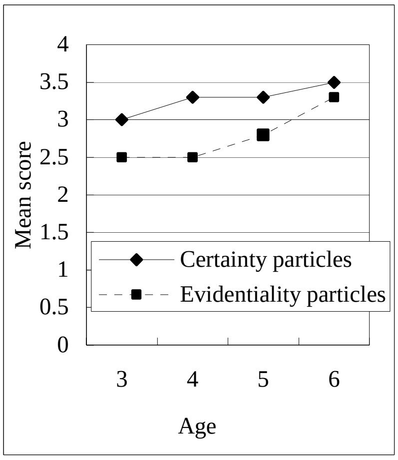


Figure 5: Comparison of particle pairs



If we turn to Figure 5, however, we find that the 3-year-old children already performed better on the certainty particle pair tasks than on the evidentiality particle pair tasks. As mentioned above, T-tests revealed significant performance differences between the two particle pairs for both the 3- and 4-year-old groups at the p<.05 level.

The differences which were observed in performances on the certainty particle pair contrasts and the evidentiality particle pair tasks have an important implication for our understanding of the role of frequency of input in the timing of acquisition of these forms. If frequency of input alone were to account for the observed behavior, we would expect to find little difference in the performances of these pairs of contrasting forms; *yo* (certainty/direct evidence) being a common denominator. That ability to make use of information encoded in the evidentiality pair (*yo-tte)* develops later (not until sometime between ages 4 and 5) than does ability to make use of the speaker certainty conveyed in the *yo-kana* contrast, suggests something else is contributing to development here.

Epistemic Modality

The children in all age groups performed better on the certainty pairs than on the evidentiality pairs. A one-way test of ANOVA conducted on the total mean score of the evidentiality contrastive pairs (*yo-tte* + *see-hear that*) and on the total mean score of the speaker certainty contrastive pairs (*yo-kana* + *know-think*) revealed main effects for age. A one-way test of ANOVA conducted on each age group's performances with modality types as independent variable revealed that all age groups except for 3-year-olds performed significantly better on certainty pairs than on the evidentiality pairs ($p < .01$ for the 4-and 5- year-old groups, $p<.05$ for the 6-year-old group).

FB understanding and comprehension of speaker certainty/evidentiality

Performances on the combined false-belief tests were categorized into pass (3, or full points), fail (0 points), and transitional (1 or 2 points). Eighteen of the 6-year-olds passed the FB tests; 5 scored 2 and 1 scored one, placing the remaining six 6-year-olds in the transitional category. Fourteen of the 5-year-olds passed the FB tests; nine were categorized as transitional; and one 5-year-old failed the tests. Eight 4-year-olds passed; 11 were categorized as transitional; and 5 failed the tests. Only one of the 3-year-olds passed the FB tests; 12 were categorized as transitional—most with scores of one point; and 12 more failed the tests.

A Pearson's correlation test conducted on FB test score and each contrastive pair score revealed significant correlations between FB test score and certainty particle pair scores ($p<0.5$), certainty verb pair scores ($p<.001$), and evidentiality verb pair scores ($p<.05$). Moreover, the FB test score reached a significant correlation level with the epistemic modality total score ($p<.001$).

Table 3 presents the false-belief test performances and percentages of above chance and below chance performances on each of the contrastive pairs. This table reveals that some children who were unable to pass the false-belief tests performed at higher than chance levels on the epistemic modality tasks (2 being the chance score). In the case of certainty particle pair (*yo-kana*), 78% of those who failed the FB test were still able to make correct choices based on the information communicated by this contrast. By comparison, only 11% of those who failed the FB tests performed at above chance levels with the evidentiality verb pair (*see-hear that*) contrast.

Table 3: False belief performance and percentage of above- and below-chance level performances on the certainty and evidentiality contrastive pairs

FB Results	Certainty Particles		Certainty Verbs		Evidentiality Particles		Evidentiality Verbs	
	Above chance	Below chance	Above chance	Below chance	Above chance	Below chance	Above chance	Below chance
Pass (n=41)	.93	.07	.83	.17	.61	.39	.39	.61
Trans (n=38)	.63	.37	.53	.47	.61	.39	.39	.61
Fail (n=18)	.78	.22	.50	.50	.39	.61	.11	.89

Statistical analysis of the overall results revealed significant main effects for FB test performance on certainty performance, and for FB test performance on evidentiality performance. Even those who failed the false-belief tests showed good grasp of speaker certainty. Specifically, 79 percent of those who failed the FB tests scored above chance on the certainty particle pair tasks. In contrast, only 39 percent of those who passed the FB tests were able to score at above chance levels on the evidentiality verb pair tasks. At the very least, this suggests that children are able to recognize some epistemic mental states in others prior to being able to pass false-belief tests (Matsui et al. In press).

We next looked for correlations between FB test results and the linguistic form of epistemic vocabulary, again using one-way tests of ANOVA. Understanding of epistemic particles among those who failed the FB tests was well above chance level. As expected, for understanding of those particles, no significant differences between those who failed the FB tests and those who passed them were found. We did, however, find a significant main effect for FB test results on the performances in verb contrast tasks ($F=11.529$, $p<.001$). A posthoc Tukey test revealed that those who passed FB test performed significantly better in the verb contrasts than those who failed ($p<.001$) and those who are in transition ($p<.01$).

3. General Discussion

Generally, the results of our experiment support our expectation that ability to recognize speaker certainty as conveyed by sentence-final particles precedes ability to ascertain speaker certainty encoded in predicates. The performance of the four-year-olds differs from that of the three-year-olds in that there appears to be cognitive development leading to inchoate ability to understand speaker certainty. The four-year-olds in our study performed better when speaker certainty information was conveyed either by the sentence-final particles or by the speaker (un)certainty verbs *know* and *think*, than they did when information about the source of information was conveyed by either particles or the evidential verbs *see* or *hear that*. Still, ability to use the particles in each of these categories exceeded the ability to effectively use the corresponding information when it was encoded in the verbs.

The pattern of certainty preceding evidentiality continues through the five- and six-year-old groups. Over time, the ability to use information encoded in the verbs in both the speaker certainty category and the evidentiality category coalesces until at age six, there is little difference except with the evidentiality verbs which continue to be problematic for many children at this age.

We suggest that early ability to make use of information encoded in sentence-final particles accords not only with theories about frequency of input and acquisition, but also with the claim that children develop an early ability to take advantage of linguistically encoded procedural (as opposed to conceptual) information. Additionally, the difficulty those who passed the FB tests had with the evidential predicates suggests that understanding of evidential strength is conceptually or representationally more demanding than understanding of false belief.

The intuition that particles and morphemes have a somewhat distinct function from that of verbs and nouns in verbal communication is widely shared by researchers who are interested in linguistic meaning. Typically, particles are seen to encode non-representational (i.e. procedural), indicative information that facilitates the manipulation of representational (i.e. conceptual) information (Blakemore 1987; Talmy 2001; Wilson & Sperber 1993). If this line of argument is on the right track, children's earlier understanding of particles may also indicate that for young children, procedural information is easier to process than conceptual information.

It is known that infants (around 10 months old) can understand the meaning of, respond to, and make use of pointing for themselves (Bretherton et. al. 1981; Butterworth 1991; Baron-Cohen 1991). Psychologists who study children's developing theory of mind ability view the act of pointing as inherent and preliminary to a full establishment of theory of mind (Baron-Cohen 1991). If that is the case, we might expect that acquisition of lexical items that encode procedural information, whose communicative function is analogous to pointing, might occur early in language, communicative, and cognitive development.

The results of the current study suggest that early understanding of particles may provide important information about children's understanding of other's epistemic mental states in general. One of the most intriguing results of our study is that understanding of particles does not correlate with understanding of false-belief. In addition, our analysis of children's performance in the hidden object task and false-belief tasks showed that nearly 80 percent of false-belief test failers scored above chance in their hidden object task involving the speaker certainty particles *yo* and *kana*. It is now widely assumed that passing false-belief tasks involves explicit representational theory of mind (Perner 1991). However, there is currently no clear consensus about whether children can grasp other's mental states prior to that, and if they do, how. It has been reported that children who fail false-belief tasks show procedural, unconscious grasp of other's mental states through eye-gaze, and such understanding has been called 'implicit' understanding of another's mind (Clement & Perner 1994; Ruffman 2000).

We speculate that procedural encoding and decoding, which is not fully representational, may be analogical to implicit understanding of beliefs, which is also thought of as not being fully representational. In other words, understanding of procedural information, conveyed by either pointing gestures or linguistic markers, may be thought of as the linguistic or communicative equivalent of implicit understanding of belief through perception. Conceptual encoding and decoding, by contrast, is fully representational (or explicit), and hence, its full use may require a fully-functioning representational mind, as in the case of explicit understanding of belief. Here, our view is close to that of Dienes and Perner's (1999): that if a child is capable of verbalizing his own or other's beliefs, the child is seen to have explicit, or representational theory of mind.

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