Children’s expression of uncertainty in collaborative and competitive contexts

Mandy Visser, Emiel Krahmer, Marc Swerts

Tilburg center for Cognition and Communication (TiCC)
Tilburg University, Tilburg, the Netherlands
Mandy.Visser@uvt.nl, E.J.Krahmer@uvt.nl, M.G.J.Swerts@uvt.nl

Abstract
We studied the effect of two social settings (collaborative versus competitive) on the audiovisual expression of uncertainty of children in two age groups (8 and 11). We conducted an experiment in which children played a quiz game in pairs. They either had to collaborate or compete with each other. We found an interaction effect of age and social setting on children’s Feeling of Knowing: 8 year old children do not seem to be affected by the social setting, contrary to 11 year old children. In a subsequent perception test, adults rated the certainty of children in clips taken from the experiment. We found that the (un)certainty of older children as well as children in competition were rated more accurately than the (un)certainty of younger children and children in collaboration. Moreover, it appeared that younger children were rated more certain in a collaborative setting and older children were rated more certain in competition. We also labeled children’s expressions for various visual and auditory features. We found that children used some of these features to signal uncertainty and that older children exhibited clearer cues than younger children.

Index Terms: audiovisual expression, (un)certainty, collaboration, competition, social development, Feeling of Knowing.

1. Introduction
Answering questions is a task people perform daily. Sometimes these questions are easy, yet sometimes they are more difficult to answer. As a result, producing an answer is often accompanied by a feeling of either certainty or uncertainty. It is generally assumed that speakers can signal their (un)certainty about the correctness of an answer with various audiovisual cues, and that others can interpret these cues correctly.

Several researchers have looked into the expression of certainty, using the Feeling of Knowing paradigm [1, 2, 3, 4]. In this paradigm, participants are asked to try and respond to sequences of questions about different topics. Typically, after this quiz-like test, participants are again presented with the same set of questions, but instead of having to answer them, participants are asked to rate their certainty, or as it has been called: their Feeling of Knowing (FOK). Analyses revealed that this self-rated FOK correlates with the presence or absence of audiovisual features. It appears that people who are uncertain about their answer, show more expression than people who are certain. For example, they tend to use fillers, like “uhm”, vary their eye gaze or move their eyebrows. It has been suggested that expressing uncertainty could be a form of self-presentation [4]. In particular, when showing their low confidence level, people do not come across as unintelligent after giving an incorrect answer, because they were already displaying their uncertainty about the correctness of the answer.

While most studies so far focused on the expression of FOK in adults, to our knowledge only one study explored the expression of (un)certainty of children [5]. Children have been argued to have a less developed meta-cognitive understanding of (un)certainty and may therefore use different nonverbal behavior compared to adults. Hence, Krahmer and Swerts [5] studied the production of (un)certainty in audiovisual speech for adults and children (around 7 years old). It turned out that there was indeed a difference between these two groups. Adult speakers were more likely to use audiovisual cues than children and their expressions were better recognized as well by independent observers.

The studies discussed above thus seem to indicate that children in the age group around 7 express their uncertainty to a lesser degree than adults. This could be explained by the fact that children in the age group Krahmer and Swerts [5] studied are not fully acquainted yet with specific display rules [6, 7]. Display rules are often viewed as conventions about appropriate behavior in certain situations, shared by members of a particular social group. They tend to be pro-social in nature and can be used for self-presentation, like in the case of showing uncertainty [8]. Nonverbal behavior is an integral component of the display rules that language users apply to regulate their social interaction [9]. People can adjust their behavior in communicating with others by recognizing and anticipating specific audiovisual cues.

There is a substantial increase in the development of knowledge of display rules. Children are only starting to recognize and use display rules around the age of 8, and by the age of 11, children are aware of about 50 percent of all display rules [7]. Presumably, children's use of audiovisual cues develops as a function of this increasing knowledge of the display rules, and children gradually learn how to adjust their nonverbal behavior to certain social situations [7, 8]. Therefore, the social setting is likely to be of more influence on nonverbal behavior as children grow older. The social situation thus is an important factor when studying audiovisual speech of children. Previous research on nonverbal behavior has rarely considered the social environment [eg. 10, 11]. Some researchers stressed the importance of social presence while studying audiovisual speech [12], but studies that consider different social settings to explain the production of audiovisual cues are lacking. However, it is likely that different social settings may have different impacts on children’s expressive behavior.

In this study, we do take different social settings that were associated with different display rules into account. We created a quiz game for our studies that could be played in two conditions, namely a collaborative or competitive setting. In this way, the participants’ goal and interest varied in each condition and thus a different social setting was created.

Furthermore, because of the social development of children and the difference in knowledge of display rules, it is necessary to take this development into account as well, unlike earlier research [5]. Therefore, two age groups were included.
in our studies, namely 8 and 11 year old children. In both age groups, pairs of children participated in either a collaboration or competition condition. The general aim of this study is to investigate the influence of a collaborative setting and a competitive setting on audiovisual speech of uncertainty of children with the age of 8 and 11.

To assess the influence of social settings and age on audiovisual expression of (un)certainy, we conducted three studies. The aim of the first study was to examine whether there was an actual difference of children’s production of FOK in different age groups and social settings. In our second study we wanted to know how children’s FOK is perceived, and whether there were any differences in that respect between age and social setting. In our third study, we focus on the audiovisual features that are used for signaling (un)certainy.

2. Study 1: production of uncertainty

In our first study, we focus on the production of (un)certainy in two social settings (collaborative and competitive) and two age groups (8 and 11 years old). We used an adaptation of the methodology of Krahmer and Swerts [5]. Instead of simply asking the factual questions to one participant at a time, we created a game-based experiment in which two participants simultaneously played a knowledge quiz. We hypothesize that the social setting has little or no effect on the FOK of the participants in the youngest age group. We do expect a comparatively large difference between the collaboration and competition condition in the age group of 11, due to the development of social consciousness [6].

2.1 Method

Participants. In total, 90 children participated in the experiment. We selected participants in two age groups, namely 8 year old children (42 children in total, 45% girls) and 11 year old children (48 children in total, 56% girls). They played the quiz game in self selected pairs. We divided these pairs randomly across two experimental settings; a collaborative setting and a competitive setting. The experiment was conducted in two primary schools in Zoetermeer, the Netherlands. Parents of the children were informed about the experiment and asked for approval for participation beforehand. Children had to hand in a signed consent form before they could participate in the quiz game.

Stimuli. For collecting children’s certain and uncertain answers, we used a quiz game inspired by Hart [3]. The quiz consisted of 30 questions, which the pairs were asked to answer taking turns, such that each participant responded to half of the questions. These questions were partly adapted from earlier research by Krahmer and Swerts [5]. They selected their questions from a Dutch version of the "Wechsler Intelligence Scale for Children" (WISC) and the children’s edition of the game Triviant Pursuit. We made sure that the correct answers of these questions consisted of only one word. In addition, we ensured that both easy and hard questions were included, in order to elicit responses that were either certain or uncertain. Even when the perceived level of difficulty of the questions differed between children, our attempt was to select a sufficient number of questions that were likely to be easy or difficult for children. In doing so, we made sure that the majority of the questions were expected to be easy for children, in order to avoid that a large proportion of difficult questions would frustrate them. An example of an easy question is “Which animals live in an aquarium?” and an example of a difficult question is “Who discovered America?”

We pre-tested the questions with one pair of children for each condition (4 pairs in total), and it appeared that by asking the selected questions, we could evoke various levels of certainty in children of both 8 and 11 years old. Therefore, we used all 30 questions in both our age groups.

Experimental procedure. Before the experiment, pairs of participants were randomly assigned to a competition or collaboration condition. They were either explicitly told that they were to collect as many points as possible together, by answering the questions of the quiz game correctly (collaborative setting), or they were explicitly told that they were playing against each other, and that they had to compete to get the greatest number of correct answers (competitive setting). To emphasize this social setting, participants wore T-shirts in the same color in the collaborative setting, and different-colored T-shirts in the competitive setting. Apart from the instruction given by the experimenter and the color of the T-shirts, the experimental procedure was exactly the same for both conditions.

After having been assigned to one of the conditions, we told the participants that the level of difficulty of the questions varied and that they were not expected to be able to answer all questions correctly. Both participants were placed in front of different computer screens, in which questions were displayed. Participants had to take turns answering. It was always clearly indicated on the screen who was to answer the current question; questions were always displayed on both screens. Participants were able to hear each other’s answers, although they could not see each other (see Figure 1). There was no time limit so the pace of the experiments was determined by the participants. Their responses were filmed using video cameras, recording their face and upper body.

![Figure 1: Experimental setting](image-url)

After each question, participants were instructed to rate how certain they were about their answer. They had to indicate their certainty on a five-point Likert scale, using individual facial representations of the items (see Figure 2). For example, a very sad face (mouth corners pulled down) represented a score of 1 (very uncertain), and a happy face (mouth corners pulled up) represented a score of 5 (very certain). These facial representations of Likert scales are fairly standard for studies involving children [e.g. 13]. The participants were instructed to select the face that best represented their feeling of certainty and show it to the camera. Children reported that it was easy to use these facial representations.

All the pairs of participants started the experiment with a training part to ensure they were familiar with the quiz and the social setting they were in. This training phase consisted of ten questions with different levels of difficulty (five for each participant). During this phase, the experimenter stressed the
importance of trying to give a correct answer. To stimulate participants to try their best and to emphasize the social setting pairs were in (competition or collaboration), they were told that (depending on the condition) the best individual or the best team of the class would receive a prize. In addition, all participants received a small reward (pencil and eraser).

2.2 Results

A total amount of 1328 FOK utterances were produced by the participants during the experiment. As Figure 3 displays, we obtained all possible scores, from zero to four on a five-point Likert scale. But as intended, the majority of the FOK scores were of level 4, in line with our attempt to make most of the questions easy. Note, though, that we still retrieved a sufficiently large number of low FOK scores to be used in follow-up experiments and measurements (see below).

We conducted a 2 x 2 ANOVA with factors age and social setting. Our dependent variable is children’s FOK. There appeared to be no main effect of age, \( F(1,89) = 0.686, n.s. \). We also did not find a main effect of social setting, \( F(1,89) = 2.008, n.s. \). However, there was a significant interaction effect between age and social condition, \( F(1,89) = 4.101, p < .05 \). Figure 3 shows that the average FOK score is not affected by whether 8 year old children are in the collaboration condition or in the competition condition (Collaboration: \( M = 3.51, SD = .51 \); Competition: \( M = 3.44, SD = .51 \)). Yet, the social setting does affect the average FOK scores of 11 year old children. The mean FOK ratings were higher for competition play (\( M = 3.57, SD = .42 \)) than for team play (\( M = 3.19, SD = .65 \)).

2.3 Discussion

In our first experiment we wanted to evoke feelings of (un)certainty in 8 and 11 year old children in both collaborative and competitive settings. We hypothesized that for 11 year old children, the social setting would affect the indication of certainty, contrary to 8 year old children. This was confirmed by the data. We found an interaction between age and social setting on the FOK of participants (see Figure 4). For 8 year old children, the social setting has no significant effect on FOK. However, 11 year old children scored their FOK significantly higher in competition play than in collaboration play. This could be explained by the further developed social consciousness of 11 year old children. According to Piaget [6], children in that age group are more socially developed than 8 year old children. Therefore, they should be more aware of the social setting that they are in.

The fact that the 11 year old children felt less certain in collaboration than in competition may be because in collaboration, participants share a goal and the accompanying responsibility for their success. Therefore, self-presentation, and thus hedging against losing face, may be more important to them. This may cause them to have lower expectations about correctness of their answer. In contrast, for competing participants the competition with their opponent might be more salient. Therefore they may care less about self-presentation. This may cause them to feel more certain. In sum, we could state that 11 year old children are more aware of the social setting than 8 year old children and thus may behave differently.

3. Study 2: perception of (un)certainty

The second study consisted of a rating experiment that tests how stimuli from the production experiment are perceived regarding cues to (un)certainty as a function of social setting and age groups. Again, we hypothesize that the social setting will be more important for 11 year old children than for 8 year old children, in perceiving expressions of (un)certainty. According to Saarni [7], children around the age of 11 are substantially more aware of display rules than children of 8. We expect children in our oldest age group to be more aware of display rules, and therefore express their uncertainty in a different way than children in our youngest age group. Moreover, children of 11 might be more aware of the social setting, and therefore we expect an effect of the social setting on the expression of (un)certainty in that age group. In this second experiment, we used data collected in the game based experiment as stimuli in a perception experiment.

![Figure 2: Participant indicating his FOK](image)

![Figure 3: Distribution of indicated FOK scores (N = 1328)](image)

![Figure 4: Interaction effect of social setting and age on FOK](image)
3.1 Method

Participants: 38 adults participated as judges in a perception experiment, containing a selection of clips of quiz playing children. These adults were all students from Tilburg University and were between 18 and 27 years old (58% female).

Stimuli: We selected 64 clips of children answering a question during the quiz game, with an equal distribution of high (maximum score of 4 on 5 point Likert scale) and low (minimum score of 0 on 5 point Likert scale) self indicated FOK scores, and an equally divided across social settings. This gave a 2 x 2 x 2 design (FOK x age group x social setting), see Table 1. The original selection of stimuli that followed was semi-random, in the sense that our selection of clips had to meet a number of criteria. First, the answers given in the selected clip had to be lexically distinct to avoid that observers would have to rate clips with similar content. Thus, no answer appeared more than once as stimulus for the perception experiment. Second, the speaker should appear in the stimuli clips twice, both with a low and high FOK score. And finally, no non-answers were taken into account, non-answers being defined as variants of “I don’t know” responses. Note also that the selected clips only contained the actual response from the child, so without the question that preceded their answer. In this way, 74 video fragments were randomly selected. After the selection, all FOK scores presented in the clips (the smileys, see also Figure 2) were blurred, so no FOK score was shown in the fragments, to prevent that observers could base their judgments on these FOK scores.

Procedure: All 64 stimuli were shown to the participants in two random orders. First, the identification number of the stimulus was presented, followed by the actual stimulus. After this, participants were asked to rate the certainty of a speaker in a clip, on a five-point Likert scale. This score is called the Feeling of Another’s Knowing (FOAK).

Table 1: Selection of stimuli for the perception test

<table>
<thead>
<tr>
<th>FOK</th>
<th>8 year</th>
<th>11 year</th>
<th>8 year</th>
<th>11 year</th>
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<tbody>
<tr>
<td>Low</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<tr>
<td>High</td>
<td>8</td>
<td>8</td>
<td>8</td>
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</tbody>
</table>

3.2 Results

The discussion of the results of this experiment is limited to significant main and interaction effects. We conducted an ANOVA with factors FOK, age and social setting. Our dependent variable is participants’ FOAK. As we expected, there was a main effect of the FOK score on the FOAK score in the perception experiment, F(1,37) = 1501.176, p < .001. The FOAK scores closely matched the original FOK scores in that the responses with a high FOK were indeed rated as having a significantly higher FOAK than responses with a low FOK. Moreover, we found main effects of both age and social setting on FOAK as well. It appeared that the FOK score of 8 year old children was rated lower (M = 2.03, SD = .31) than the FOK of 11 year old children (M = 2.14, SD = .22), F(1,37) = 10.487, p < .01. Moreover, the FOAK score of children who were competing was rated lower (M = 2.03, SD = .28) than children who were collaborating (M = 2.14, SD = .27), F(1,34) = 8.055, p < .01.

Beside these main effects, we found several interaction effects as well. A significant two-way interaction was found between age and FOK score, F(1,37) = 161.792, p < .001. It appeared that the difference between low FOK and high FOK responses was less extreme for the clips of children around the age of 8 than for 11 year old children. Table 2 illustrates that both low and high FOK score are rated more correctly by participants of the perception test. In other words, children of 11 seem to be more expressive in showing their (un)certainty than children of 8. A similar interaction is seen in the difference between collaboration and competition condition, F(1,37) = 37.541, p < .001. Table 3 shows that stimuli with both low and high FOK scores are rated more correctly in the competition condition. However in the collaboration condition, the difference between low and high FOK responses is much smaller. In other words, in the collaboration condition FOK scores were rated much less extreme than the FOK scores in the competition condition, indicating that children in the competition condition were more expressive in showing their (un)certainty than children in the collaboration condition.

Table 2: Interaction effect of age and FOK on FOAK

<table>
<thead>
<tr>
<th></th>
<th>Low FOK M</th>
<th>SD</th>
<th>High FOK M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 years old</td>
<td>1.29</td>
<td>.42</td>
<td>2.77</td>
<td>.29</td>
</tr>
<tr>
<td>11 years old</td>
<td>1.01</td>
<td>.30</td>
<td>3.28</td>
<td>.28</td>
</tr>
</tbody>
</table>

Table 3: Interaction effect of social setting and FOK on FOAK

<table>
<thead>
<tr>
<th></th>
<th>Low FOK M</th>
<th>SD</th>
<th>High FOK M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>1.29</td>
<td>.31</td>
<td>2.99</td>
<td>.31</td>
</tr>
<tr>
<td>Competition</td>
<td>1.01</td>
<td>.39</td>
<td>3.05</td>
<td>.27</td>
</tr>
</tbody>
</table>

Finally, we found an interaction effect between age and the social setting on the FOAK of participants, F(1,37) = 83.194, p < .001. Figure 5 shows that 8 year old children are rated more certain when they are collaborating (M = 2.25, SD = .34) than when they are competing (M = 1.81, SD = .39). However, 11 year old children are rated more certain when they are competing (M = 2.26, SD = .28) than when they are collaborating (M = 2.03, SD = .23).

Figure 5: Interaction effect of social setting and age on FOAK

3.3 Discussion

In the perception experiment, participants saw 64 clips of children answering questions, in which they had to judge their (un)certainty. The stimuli contained two age groups and two social conditions. We hypothesized older children to express their uncertainty in a different way than the younger children. Moreover, we expected an effect of the social setting on the expression of (un)certainty for 11 year old children. We found two main effects. First, it appeared that participants rated the (un)certainty of 8 year old children lower than the
(un)certainty of 11 year old children. Note that our earlier production experiment revealed no significant effect of age on the FOK of children. In other words, their FOK ratings are on average similar. However, we did find an effect of age for the perception of FOK. Therefore, while the feeling of uncertainty appears to be similar across the two age groups, there is a difference in the way they express this confidence level, as judges rate their FOAK differently. The second main effect that we found concerned social setting (collaboration versus competition). It appeared that children in competition expressed themselves more uncertain than children in collaboration, which contradicts expectations as a result of the first study, where we found that 11 year old children have a higher FOK in competition than in collaboration. It appears that the FOK and the perception of expressions of FOK (FOAK) are two independent factors for age and social setting. In addition, we found several interaction effects. The first interaction effect on FOAK appeared between age and FOK. Participants rated FOK scores more correctly for 11 year old children than for 8 year old children. This could mean that 11 year old children are better at expressing themselves. Moreover, we found an interaction of social setting and FOK that affects FOAK. Participants rated FOK scores more correctly for competing children than for collaborating children. Again, this is not as we expected. We expected, due to display rules, that expressions of (un)certainty would be affected by the competition condition, for self-presentation. However, there is still an effect of social setting on the correctness of perception of expressions of (un)certainty.

Finally, we found an effect of both age and social setting on the perception of expressions of (un)certainty. 8 year old children are rated more certain in collaboration and 11 year old children are rated more certain in competition. This could be due to the increased social awareness of 11 year old children, compared to 8 year old children, and to the importance of display rules in both social settings [7, 8]. In competition, for self-presentation it is more important to express more certainty than in collaboration. Children around the age of 11 are more aware of these display rules, and therefore express more certainty in competition than in collaboration.

4. Study 3: Expression of uncertainty

We can state that there is a difference between the expressions of (un)certainty by children in different conditions (age and social setting). However, we still have no knowledge about the audiovisual features that are used by children in different age groups and social settings, when expressing (un)certainty. Therefore, the aim of our third study is to gain insight into possible features that are important for showing and detecting (un)certainty. Therefore, we labeled the expressions of stimuli, used in the perception test.

4.1 Method

Labeling and annotation. All clips of participating children used in the perception test were manually labeled by two coders independently. According to an explicit labeling protocol, they annotated the presence or absence of the following auditory and visual features. We chose for these features being based on earlier reports that showed their potential relevance [4, 5]. Our visual labels were roughly based on earlier research by Ekman and Friesen [14]. They formulated a coding system by examining single muscular actions of facial expression. According to their Facial Action Coding System, these muscular actions are the fundaments of more complex facial expressions. The three auditory labels were used in earlier research according to the FOK paradigm [1, 2, 4].

- Filler: whether the participant used fillers (words and non-words, like “uhm”) or not.
- Delay: whether the participant took some time to respond or responded immediately after asking the question.
- High intonation: whether the participant ended his answer in a high boundary tone or not.
- Eyebrow movement: whether the participant moved one or both eyebrows during the response or not.
- Smile: whether the participant smiled (moving corners of the lips) during the response or not.
- Funny or thinking face: whether the participant produced a “marked facial expression” during the response or not.

To avoid circularity, coders were blind to the participant’s score of FOK and social situation during the labeling. Features were only labeled as being present when this was clearly the case. Before the actual labeling, the coders labeled several clips together for practice. There appeared to be no difficulty in labeling the utterances. Inconsistent labels were discussed and consensus was reached. This procedure resulted in an explicit labeling protocol.

4.2 Results

We used analysis of variance (ANOVA) with medium and high FOK, age and social setting as factors. Our independent variables were the labeled audiovisual features. There appeared to be an effect of FOK on the use of audiovisual features, $F(1,63) = 30.06, p < .001$. When participants indicated a low FOK, they used more features than when they indicated a high FOK. Table 4 shows that low FOK answers are more likely to be produced with a longer delay, with high intonation, with eyebrow movements and with a funny face, compared to high FOK answers. However, there was no effect of age, $F(1,63) = .318, ns$, or social setting, $F(1,63) = .20, ns$, on signaling features. This is, it did not matter in which condition children participated or in which age group they were in, on average, they did not express different features.

4.3 Discussion

To obtain a better insight into the effect of different social settings and age groups on the perception of (un)certainty, all 64 video clips, used in the perception experiment, were labeled
according to 6 audiovisual features. It appeared that there was, in line with earlier research [5], a difference of use of features in low and high FOK. However, in contrast to earlier findings, there was neither an effect of age groups, nor of social setting. This could be due to the labeling of limited features, or a different factor that may influence the perception of (un)certainty in both social settings and age groups. Possibly, it could be that a simply binary distinction between absence and presence may not reveal subtle differences between age and social setting; future research should test whether more gradient distinctions in types of features may show differences between these factors.

5. General Discussion and Conclusion

With this study, we intended to explore the influence of different social settings on the expression of (un)certainty in different age groups. Therefore, we conducted three studies on signaling and detecting (un)certainty.

The aim of the first study was to gain more inside of the influence of collaboration and competition on children’s feelings of (un)certainty in different age groups. It was interesting to observe that there was a significant difference in the effect of social setting in 8 and 11 year old children on FOK: 11 year old children’s FOK appear to be more affected by social setting than 8 year old children. This can be explained by the social developmental stage these two age groups are in. According to Piaget [6], children of 11 years old are more aware of their social appearance than 8 year old children. From this first study, we can conclude that the social setting is important for feelings of (un)certainty, during the social development of children.

After this production experiment we conducted a perception experiment. The aim of this second study was to examine how children’s FOK perceived by adults, and whether there were any differences in that respect between age and social setting. From this perception experiment, we can conclude that older children and children playing in competition have more obvious FOK expressions. This is in line with the assumption that children learn to use nonverbal behavior gradually [15], although it contradicts our expectation, that children that are older and play in competition are more aware of display rules than younger children and play collaborative. We also found an interaction effect of age and social setting on participants’ FOAK, which supports our hypothesis about the effect of social settings and expression of (un)certainty. We can state that both social setting and age are important factors for the perception of expressions of (un)certainty. Expressions of 8 year old children and children playing in collaboration are less well recognized than children of 11 and children playing in competition. Moreover, the interaction effect between age and social setting on FOAK shows that the knowledge of display rules is important for expressing (un)certainty.

In our third study, we focused on the audiovisual features that are used for signaling (un)certainty. While we did find that such features distinguish between low and high FOK answers, we have so far not found any effect of social setting or age on these features. We can conclude that the perception of (un)certainty, due to the factors age and social setting, probably have a different cause than expected. It would be interesting to examine our found contradiction more closely.

In general, our study revealed that a setting of collaboration or competition is an important factor for expressing (un)certainty. Therefore, we recommend future research to consider social settings when examining nonverbal behavior.

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