for teaching and learning. We aim at showing the flexibility of natural pragmatic frames by means of their social emergence with presenting the ontogenetic development of a pragmatic frame along a child's age and capabilities. As mentioned earlier, Bruner (1983) (p. 78 ff.) analyzed the development of the book-reading pragmatic frame in adult–child interaction. In **Table 6**, we show a respective table for this natural human–human interaction, created with the same tool of analysis we applied for the robot learning literature.

2.3.1. Bruner (1983)

2.3.1.1. Focus

Bruner observed a mother and her son during the natural occurrence of (picture) book reading during the child's second year of life.

2.3.1.2. Interaction Category

The interaction is about explicit training and can be lead by both the parent and the child. The parent directs the child's attention, but the child can also initiate the interaction by first pointing to an image, for example. The parent guides the infant to produce an acceptable label.

2.3.1.3. Pragmatic Frame

For the book-reading pragmatic frame, Bruner (1983) (p. 78 ff.) identified a set of acceptable tokens for the mother's utterances (**Table 6**). Similar to our analysis, he also classifies her utterances into key utterance types, which we will here present with their most frequent tokens (≥10%) (taken from Bruner (1983) (p. 78 ff.)):

- *Attentional Vocatives*, "Look!" (94%);
- *Queries*, "What's that?" (67%);
- *Labels*, "X (=a stressed label, a noun for a whole object)" (42%), "It's an X" (16%), "That's an X" (13%);
- *Feedback*, "Yes" (63%), "Yes, I know" (10%).

The most flexibility of form is thus present in the presentation of the label (i.e., the learning content) and thus in the slot. Positive feedback is the common type, and negative feedback with or without correction is much less frequently given (only 15% of feedback utterances). The child participates with vocalization, gesture, smile, eye contact, and search for object. Not surprisingly, his participation increases with age and changes as, for example, undifferentiated deictics develop to pointing gestures. The initialization of the interaction can also come from the child who points to an image resulting in the omission of the attentional vocative the mother usually initiates the interaction with. The mother determines how often she will ask for the label, as she concludes the interaction when she is satisfied with her son's performance. Importantly, the mother's and child's turns appear in a sequence and only overlap by accident (about 1% of the time).

Concerning the development of the pragmatic frame, Bruner (1983) (p. 124) describes that the mother adjusts the level of variability and difficulty to her son's age and capabilities: "The mother restricts the task to the degrees of freedom that she believes the child can handle, and once he shows signs of doing better than that, she raises the level both of her expectancies and of her demands on the child."

At first (**Table 6**, Frame 1A), the child only produces babble strings and smiles for his turn upon which the mother utters positive feedback and the correct label.

Then (**Table 6**, Frame 1B), with the appearance of standard lexical labels, she is only satisfied with the child's answer, when he produces a lexeme-length babble. As soon as her son acquired the capability to produce words, she instead insists on words.

Another big change happens, when the mother knows that the child knows the label she asks him for (**Table 6**, Frame 1C). Then, her intonation pattern in the query ("What's that?") switches from a rising to a falling intonation. The child then gazes at the mother, smiles, and to tease her delays his answer a bit. With her positive feedback, she would then elaborate comments and questions for new information (e.g., "What's that?" "Fishy." "Yes, and what's he doing?"; the rising intonation which was previously on the labeling query now shifts to "doing" in the new turn), developing the frame from labeling to predication.

TABLE 6 | A book-reading frame in adult–child interaction (Bruner, 1983).

Teaching parent actions	Child learner actions
Frame 1A	
1. Direct attention: **optional**, **form**, point and/or verbal command "Look!"	2. Attention: **form**, gaze to image of joint attention
3. Prompt performance: **form**, "What's that?"	4. Act: **form**, babble strings and smiles
5. Binary feedback + input: **form**, positive feedback and label, "Yes, a fish!"	6. Act: **form**, babble strings and smiles
7. Binary feedback: **form**, positive feedback, "Yes"	
Frame 1B	
1. Direct attention: **optional**, **form**, point and/or verbal command "Look!"	2. Attention: **form**, gaze to image of joint attention
3. Prompt performance: **form**, "What's that?"	4. Act: **form**, lexeme-length babble or words
5. Binary feedback: **form**, positive feedback, "Yes"	
Frame 1C	
1. Direct attention: **optional**, **form** point and/or verbal command "Look!"	2. Attention: **form**, gaze to image of joint attention
3. Prompt performance: **form**, "What's that?"	4. Act: **form**, label, "Fishy"
5. Binary feedback + prompt performance: **form**, positive feedback and label, "Yes, and what's he doing?"	6. Act: **form**, words
7. Binary feedback: **form**, "Yes"	

The parent decides if and how often steps (4) and (5) of Frame 1A occur. The parent decides how often steps (3) and (4) of Frame 1B are repeated. The parent decides how often steps (5) and (6) of Frame 1C are repeated.

2.3.1.4. Implicit Knowledge

There is no implicit knowledge. The pragmatic frame itself however carries important information for learning (where the learning content is, what type it is, and how to process it).

Table 7 summarizes shared points and highlights the major shortcomings of the various presented papers. Compared to natural adult–child interaction (final row of the table) like the one we describe above, only few rigid frames are used in the robot learning approaches which in general are not learned.