Communicative Feedback in Response to Children's Grammatical Errors

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Abstract

Children learning their mother tongue engage in interactive communication starting from the early stages of their development. In a large-scale study of transcribed child-caregiver conversations, we investigated the role of Communicative Feedback in response to children's grammatical errors. We found evidence for both positive and negative feedback signals that are useful for learning the grammar of one's native language: Caregivers are more likely to provide acknowledgments if an utterance is grammatical, and they are more likely to ask for clarification if an utterance is ungrammatical. Further, we investigate how children react in response to negative communicative feedback signals and find evidence that grammaticality is improved in direct follow-ups to negative feedback signals. This study provides the largest and most comprehensive evidence supporting the presence and effectiveness of communicative feedback signals in grammar learning, broadening the literature on communicative feedback in language acquisition more generally.

Keywords: language acquisition; communicative feedback; clarification requests; acknowledgements

Introduction

Long before their linguistic skills are fully developed, children engage in conversational exchanges with people around them, which allows them to refine their linguistic knowledge by leveraging various signals of language use in interaction (Bohn & Frank, 2019; Bruner, 1985; E. V. Clark, 2018; Tomasello, 2003). One such signal is *corrective* feedback (and its variants such as negative evidence, reformulations, or recasts). It describes situations in which the caregiver provides the child with a corrected form of an erroneous utterance ("I goed to school." - "You *went* to school?"). This phenomenon has been studied extensively in the developmental literature, but the research community has not reached a consensus regarding its availability to children and/or its effectiveness for first language acquisition (e.g., Brown & Hanlon, 1970; Chouinard & Clark, 2003; E. V. Clark, 2020; Demetras, Post, & Snow, 1986; Farrar, 1992; Hiller & Fernandez, 2016; Marcus, 1993; Morgan, Bonamo, & Travis, 1995; Nelson, Carskaddon, & Bonvillian, 1973; Saxton, Backley, & Gallaway, 2005).

In the current study, we focus on the role of another kind of social signal that has come to be called *Communicative* Feedback (hereafter, CF). CF represents signals that the listener (here, the caregiver) sends to the speaker (i.e., the child) to indicate communicative success or failure depending on whether the listener thinks they understood the meaning intended by the speaker (for an overview, see Nikolaus & Fourtassi, 2023). The main difference with corrective feedback is that CF does not necessarily aim at correcting the child but rather at reaching and maintaining mutual understanding between interlocutors (H. H. Clark, 1996). Despite having a communicative rather than a teaching agenda, the child can still use such signals to learn, either by revising their erroneous linguistic assumptions or by confirming/reinforcing their correct knowledge (Nikolaus & Fourtassi, 2021).

Suppose the child produces an erroneous utterance. Even if the child is not corrected (as in the case of recasts), they can receive *negative* signals of communication breakdown (e.g., a clarification request) that they can use to revise the expression of their communicative intent ("Went to school." - "Who went to school?" - "He went to school.").[1] If the child produces a well-formed utterance, the caregiver can provide acknowledgments (e.g., backchannels), offering the child *positive* feedback of communication success and indirectly confirming their current hypotheses about the linguistic structures they used ("He went to school." - "Oh I see!").

Previous work has provided evidence for the role of such feedback in children transitioning from non-speech to speech-like vocalizations (i.e., babbling, Goldstein, King, & West, 2003; Lopez, Walle, Pretzer, & Warlaumont, 2020; Warlaumont, Richards, Gilkerson, & Oller, 2014) and for transitioning to the first intelligible words (Nikolaus, Prévot, & Fourtassi, 2022). Here, we investigate whether similar communicative signals are available and helpful to children in regard to the development of grammatical speech (at both the morphological and syntactic levels).

We consider negative CF when caregivers provide clarification requests ("Went to school." - "What?") and positive CF when caregivers provide backchannel responses (e.g., "uh-huh") or acknowledge repetitions ("He went to school." - "He went to school."). Some previous work did study the role of clarification requests and of exact repetitions as a (weak) learning signal (Bohannon & Stanowicz, 1988; Demetras et al., 1986), but findings from these studies have been difficult to interpret, given several methodological issues and contradicting results (Marcus, 1993; Morgan et al., 1995; Morgan &

[1]See also Saxton (2000) about the difference between negative *evidence* and negative *feedback*.

Travis, 1989). More recently, the effects of negative feedback have been revisited in a corpus study of one child (Saxton, 2000) as well as in an intervention paradigm (Saxton, Houston–Price, & Dawson, 2005). The findings suggest that children are indeed responsive to negative feedback as shown by an increase of grammatical follow-ups in response to error-contingent clarification requests.

The current study Here, we present the largest (in terms of sample size) and most comprehensive corpus study of CF for grammatical errors in child-caregiver naturalistic conversations. We considered a wide range of positive and negative CF signals, including exact as well as partial repetitions ("I went to school." - "You went to school."), backchannel responses, and clarification requests of various kinds (open and restricted requests, as well as recasts). Thanks to automatic measures, we analyzed these cues in large-scale data of English-learning children conversing with their caregivers (MacWhinney, 2014). We tested both 1) the usefulness of CF as reliable signals to children (i.e., more negative CF following ungrammatical utterances and more positive CF following grammatical utterances), and 2) the effect of these signals on children's grammatically as reflected in children's immediate follow-up utterances.

To ensure reproducibility, we make the source code of all analyses publicly available: `https://github.com/mitjanikolaus/childes-communicative-feedback`.

Methods

Data

We analyzed 3-part micro-structure sequences consisting of 1) child's utterance, 2) caregiver response, and 3) the child follow-up (following previous work like Bavelas, Gerwing, and Healing (2017); Nikolaus, Prévot, and Fourtassi (2022); Warlaumont et al. (2014)). Hereafter, we will call this sequence URF (Utterance, Response, Follow-up). An example for such a sequence could look as follows:

Utterance (Child): *Need some milk*
Response (Caregiver): *Hm?*
Follow-up (Child): *I need some milk.*

— EllisWeismer corpus, LT/42pc/22175.cha

Our analyses are based on transcribed conversations from a subset of the English CHILDES corpora (MacWhinney, 2014). We follow Nikolaus, Prévot, and Fourtassi (2022) for the extraction of URF sequences and discard all sequences that contain non-speech and non-intelligible utterances.

Annotations and Corpus Selection

Grammaticality Corpora in CHILDES follow the CHAT transcription format (MacWhinney, 2017), which supports the annotation of grammatical errors using dedicated coding schemes. In order to obtain a better understanding of the quality and quantity of errors annotated, we grouped all annotated errors into error type classes, using a coding scheme slightly adapted from Hiller and Fernandez (2016) and Saxton, Houston–Price, and Dawson (2005).[2] A list of error types can be found in the legend of Figure 1. We excluded all utterances for which no obvious mapping could be made (sometimes error annotations are annotations of slang, such as "I'd [: I would]", or "I was runnin' [: running]"; these cases are not considered grammatical errors).

Figure 1 presents the proportion of child errors for different corpora. We find that there are only a few corpora in which a substantial number of errors were annotated. Inspecting more closely the distribution of error types, it becomes apparent that certain corpora only focused on certain error types (e.g., in the Kuczaj corpus, there were almost exclusively `tense_aspect` errors annotated). In the following, we only considered corpora that (1) included at least 1% errors in child utterances and (2) included a range of different error types annotated. This left us we the following set of seven candidate corpora: Thomas, Providence, MPI-EVA-Manchester, Braunwald, Lara, EllisWeismer, and Bates.

For these candidate corpora, we performed some manual annotations as a sanity check for our research purposes. For each corpus, we randomly selected 3 transcripts. The first author annotated grammaticality (on a binary scale) of all children's utterances until we reached a threshold of 100 annotated utterances within the transcript.

Table 1: Inter-annotator agreement (Cohen's κ), Precision, and Recall for the grammatical error annotations in 7 different corpora.

	Cohen's κ	Precision	Recall
Bates	0.43	0.89	0.31
Thomas	0.05	1.00	0.03
MPI-EVA-Manchester	0.41	0.80	0.31
Providence	0.65	0.92	0.52
Braunwald	0.49	0.86	0.42
Lara	0.62	0.77	0.57
EllisWeismer	0.68	0.91	0.59

As shown in Table 1, inter-annotator agreement between our annotations and the annotations in CHILDES vary to a large degree. Importantly, however, we find that error precision is overall high and recall rather low, indicating that numerous errors were not annotated in CHILDES, but the errors that *were* annotated are generally agreed upon.

For the remainder of the paper, we only consider corpora for which we obtained substantial agreement scores: Providence (Demuth, Culbertson, & Alter, 2006), Lara (Rowland & Fletcher, 2006), and EllisWeismer (Moyle, Weis-

[2]To simplify their coding scheme, we don't distinguish errors of omission/insertion/substitution and group regular and irregular past tense errors in the group `tense_aspect` (thereby also including errors with e.g. participles). Further, we merge regular and irregular plural errors and include all kinds of subject-verb agreement errors (third-person s, wrong use of is/are) in the group `sv_agreement`).

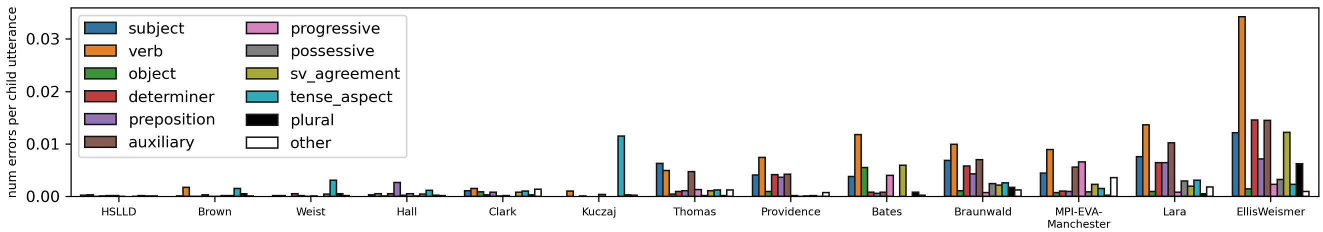

Figure 1: Proportion of child errors normalized by total number of child utterances. We only display English CHILDES corpora that include at least 100 annotated errors.

mer, Evans, & Lindstrom, 2007). These contained a total of 109,536 micro-structure sequences (URF) from 664 transcripts of 127 children. 5,593 (5.1%) of the children's initial utterances were ungrammatical, and 4,049 (3.7%) of their follow-ups. The children were 12 to 48 months old.

Clarification Requests We annotated clarification requests using two complementary approaches. First, we use a model for automatic annotation of speech acts in child-caregiver conversations (Nikolaus, Maes, Auguste, Prévot, & Fourtassi, 2022) and select all utterances that are labelled as "Eliciting questions (e.g., hmm?)" or "Requests to repeat utterance". The model detected mostly open clarification requests, such as "what?", or "huh?".

Secondly, in order to include other kinds of clarification requests such as restricted requests and restricted offers (Dingemanse & Enfield, 2015) we also considered questions that are marked by repetition of the previous utterance (e.g., "Went to the house" - "Who went to the house?"). Previous research has found that repair often involves a repetition (Dingemanse & Enfield, 2015; Fusaroli et al., 2017; Jefferson, 1972; Kendrick, 2015; Purver, Hough, & Howes, 2018; Schegloff, Jefferson, & Sacks, 1977).

We calculated repetition scores for all child utterances followed by a caregiver utterance. After excluding a set of stopwords and stemming, we calculated `rep_utt = #words_overlap/#words_utt` and `rep_response = #words_overlap/#words_response`, where `#words_overlap` is the number of words that are both in the utterance and the response, `#words_utt` the words of the utterance and `#words_response` the words of the response. We only counted unique words. Then, we randomly sampled a set of 200 utterance-response pairs for which the response was a question (marked by a question mark in the transcript) and the repetition ratios were greater than 0. We manually annotated these pairs for whether the response was a clarification request or not.[3] Figure 2 shows the relationship between the two repetition ratio measures and whether a response is a clarification request. The annotated data was used to train a logistic regression model that classifies clarification requests based on the repetition ratios.[4] This classifier reached an F-score of 0.82 on the training set. The fitted decision boundary is shown in the graph. We found that for distinguishing clarification requests from other responses, mainly the response repetition ratio (`rep_response`) was important. We annotated another 100 utterances as evaluation set and obtained an F-score of 0.85 (precision: 0.93, recall: 0.78).[5]

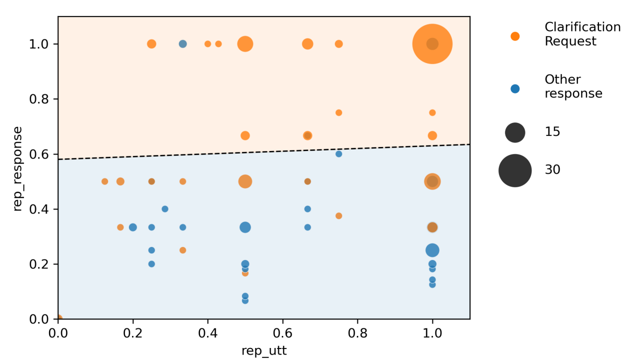

Figure 2: Clarification requests and other responses as a function of repetition ratios. As many points have the same repetition ratios, the number of points is indicated by the size of the dots. The decision boundary is shown as a striped line.

Acknowledgements To annotate acknowledgments, we included all responses that start with specific keywords (e.g., "uhhuh", "mhm", "okay", "alright", "yeah"). We excluded cases in which these keywords are following a question, in that case they are responses and not backchannels. This keyword-based method includes many common backchannel responses, but misses repetition-based acknowledgements (e.g., "It isn't very nice is it?" – "It isn't."). To identify such acknowledgements, repetition ratios can also be used as a fea-

[3] We included requests for confirmation ("He went to school." - "Did he?"), as they also communicate a negative feedback signal to the speaker: The interlocutor is not sure whether they understood the speaker correctly (see also Kendrick, 2015).

[4] We evaluated also a non-linear SVM on the data but found that performance did not improve.

[5] Manual inspection of misclassified examples showed that cases in which the caregiver asks a follow-up question were sometimes wrongly classified as clarification requests. Other cases with synonyms in restricted offers were not classified as clarification requests (e.g., "I want spoon." - "You'd like a spoon?"). Additionally, the stemmer did not stem certain colloquial word forms ("wanna") correctly, which led to incorrect repetition ratios.

ture (Fernández, Ginzburg, & Lappin, 2007).

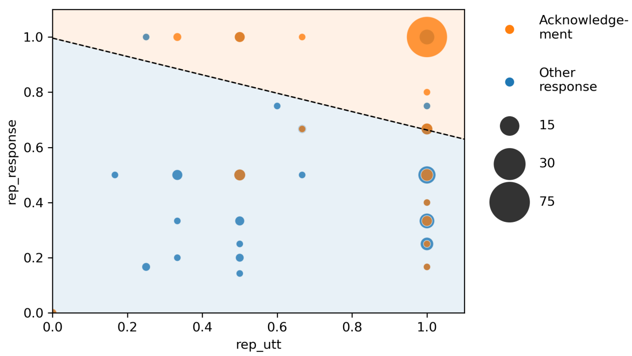

Figure 3: Acknowledgements and other responses as a function of repetition ratios. Number of points is indicated by dot size. The decision boundary is shown as a striped line.

We manually annotated another 200 utterance-response pairs, but this time including only responses that were not finished with a question mark. All responses that approve the understanding of the child's utterance were marked as acknowledgements. Figure 3 shows the relationship between the two repetition ratio measures and whether a response is an acknowledgement.[6] We also fit a logistic regression to classify acknowledgements, which reached an F-score of 0.82 for the training utterances and 0.84 (precision: 0.82, recall: 0.82) on a separate set of 100 evaluation utterances.[7]

Table 2 provides an overview on the automatically annotated clarification requests and acknowledgements.

Table 2: Number of clarification requests and acknowledgements that were annotated using speech acts, keywords and repetition features.

Clarification Requests		
Speech Act	Repetition	Total
519	7,540	8,028
Acknowledgements		
Keyword	Repetition	Total
20,398	14,103	32,214

Analyses

Caregiver's Clarification Requests

Figure 4 compares the difference in proportion of clarification requests to grammatical and ungrammatical child utterances. The graph suggests that clarification requests are used more often in response to ungrammatical sentences. We supported this hypothesis using a mixed-effects GLM that predicts whether a clarification request was given as a function of whether the child utterance was grammatical and child age (in months), including a random intercept for the child identifier. The estimated fixed effect for the grammaticality of the child utterances was negative ($\text{utt\_is\_grammatical} : \beta = -0.516, SE = 0.055, p < 0.001$), validating our observation.[8]

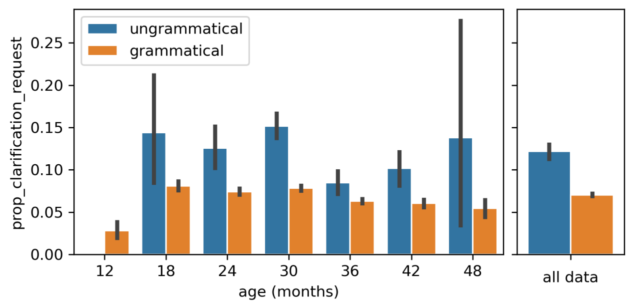

Figure 4: Proportion of caregiver's clarification requests to children's grammatical and ungrammatical utterances. The error bars indicate 95% confidence intervals.

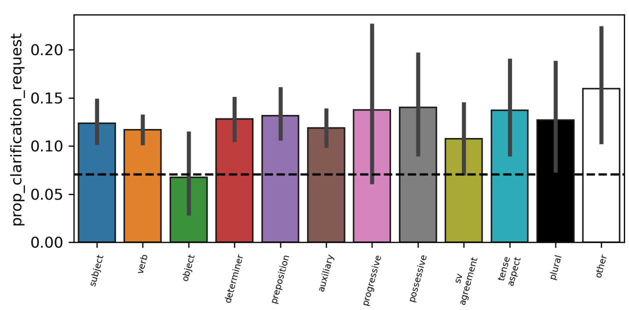

Figure 5: Proportion of caregiver's clarification requests to children's utterances with different error types. The baseline ratio (proportion of clarification requests after grammatical utterances) is indicated as a striped line.

Subsequently, as illustrated in Figure 5, we were interested in whether caregivers respond with clarification requests primarily to certain kinds of grammatical errors, or whether they are used for all kinds of errors. We found that the pattern of increased use of clarification requests is not specific to certain kinds of errors, but holds for almost all error types (with the exception of syntactic `object` errors).

[6] We did not stem the words for calculating the repetition ratios for this case, as this would hide small morphological modification which could in fact be corrections. In this case the utterance is not an acknowledgement, but rather the contrary.

[7] Manual inspection showed that many misclassified examples are cases in which the response is a repetition with minimal changes, which however changes the overall semantics and therefore pragmatics of the utterance.

[8] The other fixed effect estimates indicated that caregivers use a decreasing number of clarification requests with increasing age of the child ($\text{age} : \beta = -0.912, SE = 0.117, p < 0.001$), and a slight decrease of the main effect with increasing child age ($\text{utt\_is\_grammatical*age} : \beta = 0.566, SE = 0.221, p < 0.05$).

Caregiver's Acknowledgements

Next, we turn to positive feedback which is provided in the form of acknowledgements. Figure 6 compares the difference in proportion of acknowledgements to grammatical and ungrammatical utterances. We found that acknowledgements are used more often in response to grammatical utterances (utt_is_grammatical : $\beta = 0.2, SE = 0.033, p < 0.001$), but this pattern is decreasing over the child's age as indicated by a negative interaction term (utt_is_grammatical*age : $\beta = -0.891, SE = 0.167, p < 0.001$).[9]

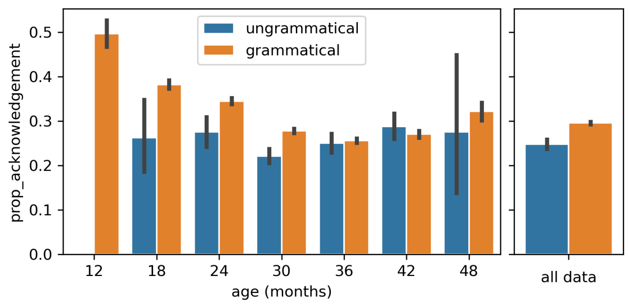

Figure 6: Proportion of caregiver's acknowledgements to children's grammatical and ungrammatical utterances.

Children's Follow-ups

Finally, we explored whether children directly respond to the negative feedback by increasing the grammaticality in their follow-up utterances. Figure 7 compares the proportion of grammatical child utterances before (utterance) and after (follow-up) the caregiver's response. In case the caregiver's response is a clarification request (right side), we observe a slight increase in grammaticality in the children's follow-ups. We fit a mixed-effects model to predict whether an utterance is grammatical depending on whether it is a follow-up (is_follow_up) and whether the response is a clarification request (resp_is_clar_req), including random intercepts for the child identifier, child age, and conversation identifier. We found a significant positive interaction term resp_is_clar_req*is_follow_up : $\beta = 0.603, SE = 0.072, p < 0.001$, demonstrating that the difference in grammaticality before and after a response is larger in the case of clarification request responses, than it is for other responses.[10]

In a follow-up analyses we looked more closely at the kind of clarification request provided by the caregiver. We found that the grammaticality in follow-ups increased only after repetition-based clarification requests, and there was no effect after clarification requests that were annotated by speech acts (which are mostly open requests).

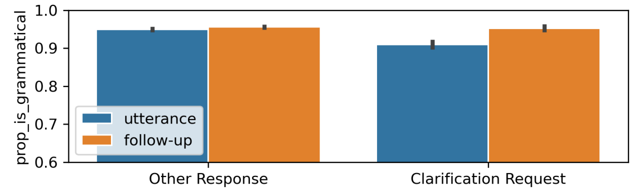

Figure 7: Proportion of grammatical utterances before (utterance) and after (follow-up) a caregiver response, which could be a clarification request (right side) or any other kind of response (left side).

Discussion

In the present corpus study, we investigated communicative signals provided by caregivers that could support children's acquisition of syntactic and morphological aspects of their native language. We found that caregivers provide both positive and negative communicative feedback in a reliable fashion: They use acknowledgments more often in response to children's grammatical utterances, and clarification requests more often in response to ungrammatical sentences. When analyzing children's ability to capitalize on these signals, we found that, indeed, the grammaticality of children's utterances increased in direct follow-ups to clarification requests from caregivers. The current studies provide quantitative evidence supporting the presence and effectiveness of communicative feedback signals in grammar learning, enriching the growing research on CF in language acquisition (E. V. Clark, 2020; Nikolaus & Fourtassi, 2023).

The role of negative feedback Previous research on the presence of negative feedback led to mixed results (Bohannon & Stanowicz, 1988; Demetras et al., 1986; Marcus, 1993; Morgan & Travis, 1989). In particular, these results have been put into question for several reasons. Some lack inferential statistics, some findings could possibly be explained by averaging artifacts, and some studies conflated multiple error categories (phonological, lexical, and grammatical) (Marcus, 1993). Another major limitation of these previous studies was the relatively small sample size (due to the labor-intensive nature of manual annotation), which has led to generalizability issues. Here, we were able to perform a much larger-scale analysis thanks to automatic annotation techniques and aggregation of previously made and publicly available manual annotations. Further, we ensured that our analyses were not subject to previous criticisms. We focused exclusively on grammatical errors, and we employed mixed-effect GLMs which control more efficiently for possible averaging artifacts

One surprising finding of the current study was that caregivers provided negative feedback to virtually all kinds of children's grammatical errors covered in this study (Figure 5).

[9] The GLM definition was the same as in the case of clarification requests, except that we were predicting the use of acknowledgements. With increasing age, the overall probability of acknowledgements decreased slightly (age : $\beta = -0.198, SE = 0.086, p < 0.05$).

[10] The other fixed effects indicated that grammaticality of follow-ups is generally lower after clarification requests (resp_is_clar_req : $\beta = -0.231, SE = 0.039, p < 0.001$), and that it is higher in follow-ups (is_follow_up : $\beta = 0.446, SE = 0.036, p < 0.001$)).

This seems to go against the predictions made by theories of CF for language learning (Nikolaus & Fourtassi, 2023). Indeed, one would expect that, if caregivers cared more about communication (and not as much about correction), they would provide more feedback in response to grammatical mistakes that impede more significantly the understanding of children's intended meaning, which is arguably the case for only a subset of the errors and would not include, e.g., errors of past tense inflection (i.e., whether the child says "goes" or "went" does not really impact the transmission of the child's intended meaning, and therefore, should *a priori* receive no negative CF signals). We investigated this observation a bit deeper by focusing on the specific case of `tense_aspect` errors. We found that the negative CF signals in response to such errors are exclusively repetition-based (no open clarification requests). By examining the corresponding URF sequences, we found that they are often recasts ("I waked your mommy right up." - "You woke my mommy right up?"), and sometimes verbatim repetitions of the error without correction: "They breaked it open." - "They breaked it open?"). This suggests, indeed, that caregivers do not glean over grammatical mistakes even when these mistakes do not impede understanding. That said, caregivers' recasts can be understood as providing the child with *both* corrective feedback (a candidate understanding) and negative communicative feedback. Thus, the results of the current work do not only speak to theories of communicative feedback but also to some aspects of corrective feedback. Further work is needed to determine how communicative and corrective feedback precisely interact in caregiver language use across development.

The role of positive feedback Several studies found that caregivers respond with exact repetitions more often in response to grammatical than to ungrammatical utterances, and could therefore function as positive feedback (Bohannon & Stanowicz, 1988; Demetras et al., 1986; Penner, 1987). However, as mentioned earlier, these studies have been criticized for several methodological issues. Regarding the specific case of exact repetitions, Marcus (1993) argued that the findings could be merely driven by the fact that almost all adults' utterances are grammatical, and therefore exact repetition of children's grammatical (as opposed to ungrammatical) utterances does not constitute evidence of parental sensitivity to children's grammatical errors. This argument does not apply to our case: The current study does not study *caregiver's sensitivity* to errors, but, rather, the availability of communicative cues that children can leverage for learning even if they do not have a corrective intent on the part of the caregiver.

Our results suggest that positive feedback in the form of acknowledgement is provided predominantly in response to children's grammatical sentences. However, this effect decreased significantly with age (cf. Figure 6). It appears that caregivers provide such *explicit* positive feedback mostly in early stages of development, until around the third year of age (this result should be taken with a grain of salt, as the data in the current study is not equally distributed across ages; it is concentrated for children aged 2 to 3 years and is very sparse for the rest). One interpretation of this finding is that, as soon as children start to produce longer and more sophisticated utterances, other (more *implicit*) forms of positive feedback become possible such as the contingency of a caregiver's response to a child utterance (see also Hoff-Ginsberg, 1987; Nikolaus & Fourtassi, 2023). In other words, children require less explicit encouragement after each correct utterance; as they grow older, they can feel understood merely by having a coherent exchange with their interlocutor. In order to obtain a complete picture of CF signals in language acquisition, such implicit signals should be the focus of future work.

Limitations and future research directions One possible confound of our analysis on grammaticality of children's follow-ups after clarification requests (cf. Figure 7) is that children are more likely to produce shorter utterances (e.g., one-word replies) as follow-up to clarification requests and these are more likely to be grammatical. We investigated this possibility by restricting the analysis to utterances that have a minimum length of 2 (or 3) words. In both cases, the effect on the grammaticality of the follow-ups decreased but was still significant for the case of minimum length of 2 words.

More generally, this points to limitations of evaluating children's follow-ups as a means to study the children's sensitivity to feedback (Figure 7, as well as Saxton, 2000; Saxton, Houston–Price, & Dawson, 2005): This approach is only taking into account immediate and verbalized evidence of children's learning. In many cases, the child might actually understand and take the feedback into account, but not demonstrate it overtly/immediately. Such more long-term effects on learning can be studied using longitudinal data collection coupled with in-lab testing (Bergelson & Aslin, 2017).

Another limitation of the present study is that it only considered verbal instantiations of communicative feedback signals that were possible to extract from the transcripts. Future work should include signals that are communicated nonverbally (e.g., head nods, frowns) or using prosodic cues (e.g., rising pitch) using multimodal corpora (e.g., Bodur, Nikolaus, Prévot, & Fourtassi, 2023; Shi, Gu, & Vigliocco, 2022).

Finally, the current analysis was only based on children learning English. Evidence suggests that communicative feedback signals such as clarification requests (Dingemanse et al., 2015; Lustigman & Clark, 2019; Ochs & Schieffelin, 1984) and acknowledgements (Cutrone, 2005; Liesenfeld & Dingemanse, 2022; Maynard, 1990) are universally used in human conversations, and can therefore be leveraged by children from different languages and cultures. Future work is required to investigate this hypothesis.

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