**Supplemental material**

*Phonetic inventories construction*

Each child’s phonetic inventory was extracted from their transcribed productions from the parent-child interaction and the ADOS-2. For a phoneme to be included within a child’s inventory, it had to be produced at least three times by the child, in any position (see Chenausky, Nelson, & Tager-Flusberg, 2017). To the best of our knowledge, there is no consensus from past autism research on the number of times a phoneme has to be uttered to be included in an inventory (e.g., at least 3 times and in the context of naturalisatic speech in Chenausky et al., 2017; more than one instance of use in Wolk & Brennan, 2013; at least once in Wolk & Edwards, 1993). For this paper, we chose the most conservative criterium for two reasons: 1) all children had very good verbal abilities and were using phrase speech quite fluently, and 2) the speech samples per child were around 50 minutes long in total, which is a high amount of data.

In order to build phonetic inventories, children’s produced phones were compared to the phonemes of the French sound system. The number of phonemes in the French sound system was based on resources on the standard French inventory (Fougeron & Smith, 1993). The complete French consonant inventory is detailed in suppl. table 1, while the French vowel inventory is detailed in suppl. table 2.

**Supplemental table 1.** Complete French consonant inventory with their respective SAMPA and IPA symbols and their description in terms of manner and place of articulation, and voicing

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SAMPA** | **IPA** | **Manner** | **Place** | **Voicing** |
| p | p | plosive | bilabial | voiceless |
| b | b | plosive | bilabial | voiced |
| t | t | plosive | dental | voiceless |
| d | d | plosive | dental | voiced |
| k | k | plosive | velar | voiceless |
| g | g | plosive | velar | voiced |
| f | f | fricative | labiodental | voiceless |
| v | v | fricative | labiodental | voiced |
| s | s | fricative | alveolar | voiceless |
| z | z | fricative | alveolar | voiced |
| S | ʃ | fricative | palato-alveolar | voiceless |
| Z | ʒ | fricative | palato-alveolar | voiced |
| m | m | nasal | bilabial | voiced |
| n | n | nasal | dental | voiced |
| J | ɲ | nasal | palatal | voiced |
| N | ŋ | nasal | velar | voiced |
| R | R | trill | uvular | voiced |
| l | l | lateral approximant | alveolar | voiced |
| w | w | glide | labiovelar | voiced |
| H | ɥ | glide | labiopalatal | voiced |
| j | j | glide | palatal | voiced |

The consonant inventory of each child was therefore built based on this list of 21 consonants:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| p | b | t | d | k | g | f | v |
| s | z | S | Z | m | n | J | N |
| R | l | w | H | j |  |  |  |

Consonants produced by a child at least three times were considered as being represented in their inventory. The percentage of represented consonants over the total number of French consonants (n = 21) was then computed for each child.

**Supplemental table 2.** Complete French vocalic inventory with their respective SAMPA and IPA symbols and their description in terms of orality, backness, height and roundedness

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SAMPA** | **IPA** | **Backness** | **Height** | **Roundedness** |
| Oral |
| i | i | front | close | unrounded |
| e | e | front | close-mid | unrounded |
| E | ɛ | front | open-mid | unrounded |
| a | a | front | open | unrounded |
| y | y | front | close | rounded |
| 2 | ø | front | close-mid | rounded |
| 9 | œ | front | open-mid | rounded |
| @ | ə | central | mid | unrounded |
| u | u | back | close | rounded |
| o | o | back | close-mid | rounded |
| O | ɔ | back | open-mid | rounded |
| A | ɑ | back | open | unrounded |
| Nasal |
| e~ | ɛ̃ | front | close-mid | unrounded |
| a~ | ɑ̃ | back | open | unrounded |
| o~ | ɔ̃ | back | open-mid | rounded |
| 9~ | œ̃ | front | open-mid | rounded |

The SAMPA phonetic alphabet contains symbols for cases of ‘indeterminacy’. These cover cases where the opposition between two vowels tend towards neutralization and their contrast can therefore be very low for certain speakers. It is very likely that this phenomenon will happen in our language sample. Especially in Belgian French, the contrasts between [e] and [ɛ], [ø] and [œ], and [o] and [ɔ] tend towards neutralization (Dominicy, 2000). Furthermore, participants are in the process of acquiring language and its sound system. Many of the children in this sample also come from different parts of Belgium and France, therefore acquiring French with different accents. It was therefore decided to use the ‘indeterminacy’ symbols for those vowels that can be very difficult to differentiate or whose contrasts might no longer exist in certain French-speaking regions when building the vowel inventory of the participants. The indeterminacy symbols and their corresponding vowels are the following:

* **E/** represents **e** and **ɛ** (e and E in SAMPA)
* **A/** represents **a** and **ɑ** (a and A in SAMPA)
* **&/** represents **ø** and **œ** (2 and 9 in SAMPA)
* **O/** represents **o** and **ɔ** (o and O in SAMPA)
* **U~/**  represents **ɛ̃** and **œ̃** (e~ and 9~ in SAMPA)

The vowel inventory of each child was therefore built based on this list of 11 vowels:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| i | E/ | A/ | y | &/ | @ |
| u | O/ | U~/ | a~ | o~ |  |

Vowels produced by a child at least three times were considered as being represented in their inventory. The percentage of represented vowels over the total number of French vowels (n = 11) was then computed for each child.

Finally, the complete phonetic inventory of each child was built by combining their consonant and vowel inventories and computing the percentage of represented phones over the total number of phonemes in the French sound system (n = 32).

*Lemmatization of words for lexical diversity*

The list of words and word approximations produced by each child in each context was extracted from the *word* tier and manually translated into their lemmatic form. Both function and content words as well as common and proper nouns were included. However, were excluded from this analysis: jargon, unrecognizable word approximations, words uttered in a foreign language, interjections, and onomatopoeias (mostly animal or vehicle sounds, *euh* ‘uh’ and all its derivations, surprise sounds, etc.).

If a word was partially stuttered, it was counted as one occurrence of the same lemma. However, if the word was repeated in its full form, each repetition was counted as one occurrence. For example, the partially stuttered *pou pourquoi* ‘w why’ was translated as one occurrence of *pourquoi* ‘why’, but the repeated *pourquoi pourquoi pourquoi* ‘why why why’ was translated as three occurrences of *pourquoi* ‘why’.

All articles and determiners were translated into their masculine singular form, except for the plural indefinite article *des* because it is irregular from the singular forms *un*/*une* ‘a’. Singular and plural subject personal pronouns were each translated into different lemmas. Irregular forms of verbs were not considered as independent lemmas. Therefore, all forms of all verbs were translated into their infinitive form. One exception was made for the expression *allez!* ‘come on!’ which comes from the verb *aller* ‘to go' but is used for cheering or encouragement and was translated into an independent lemma. Compound words were counted as one lemma and some very common frozen expressions were also counted as one lemma. No distinction was made between homographs. Suppl. table 2 shows a set of examples for the lemmatization of children’s produced words, and suppl. table 3 describes the characteristics of our language sample used to measure lexical diversity.

**Supplemental table 3.** Examples of the lemmatization of children’s words

|  |  |  |  |
| --- | --- | --- | --- |
| Type of word | Produced word | Translated lemma | English meaning |
| Possessive determiner | mon/ma/mes | mon | my |
| Definite determiner | le/la/les | le | the |
| Indefinite determiner | un/unedes | undes | a |
| Subject personal pronoun | jeilelles | jeilelles | Ihethey (feminine) |
| Common noun | copinesnénéphantbateau | copainéléphantbateau | friendelephantboat |
| Proper noun | monsieur patatePauline | monsieur patatePauline | mr Potato HeadPauline |
| Verb | ai finivais/vont/allais | finiraller | to finishto go |
| Adjective | grande | grand | big |
| Frozen expression | en faitparce quequelque chosequand mêmeau revoir | en faitparce quequelque chosequand mêmeau revoir | in factbecausesomethingall the samegoodbye |

**Supplemental table 4.** Lexical diversity. Language sample characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **Context** | Number of tokens | Number of types |
| mean (sd)range | mean (sd)range |
| TD | ADOS-2 | 1018.5 (442.81)642-2069 | 205.8 (47.67)129-273 |
| Parent-child interaction | 701.6 (462.08)111-1613 | 151.6 (51.87)56-220 |
| ASD | ADOS-2 | 1021 (378.47)435-1658 | 185.8 (41.45)130-261 |
| Parent-child interaction | 737.56 (186.79)410-962 | 148 (21.48)113-186 |

*Coding of French grammatical inflections*

The coding of French grammatical inflections followed conventions established by Thordardottir (2005), with slight adaptations. Utterance segmentation did not follow Thordardottir’s conventions (2005) (i.e., following intonation contours and grammatical completeness or a pause greater than 400 ms), but followed a 250-ms pause rule. All false starts, interruptions, or unintelligible utterances were excluded. Single-word utterances were included in the analysis if they were not abandoned utterances (e.g., *oui* ‘yes’, *non* ‘no’, single-word answers to a question). The first 110 complete, intelligible, clear utterances of each child in each context were coded for grammatical inflections based on the orthographic transcriptions of the children’s utterances.

Following the coding conventions established by Thordardottir (2005), free morphemes were separated by a space and bound morphemes were separated from the word they were attached to by a slash (“/”). Words were transcribed into lemmas (i.e., the infinitive form for verbs, the singular form for nouns, the masculine singular form for adjectives and pronouns). Multiword expressions were counted as one word. Erroneous inflections were not coded, except if they followed typical overgeneralization rules (e.g., *je prendais* instead of *je prenais* ‘I was taking’). Verbs were coded for mood (if different than indicative), tense (if different than present) and person. Nouns were coded for plural but not singular and were not coded for gender either. Articles were counted as single free morphemes and were not coded for plural or gender agreement because they were viewed as forming part of the noun inflection. Adjectives and past participle of verbs were coded for gender and number agreement with their referents regardless of audibility (marks of gender and number are often not pronounced in French) because they must agree with the noun they modify or their referent, respectively. Singular possessive adjectives were coded for gender agreement with their referent and plural possessive adjectives were coded for number but not gender. Personal pronouns were each coded as different words. Clitic pronouns were coded for gender and number. When the pronoun only had one form for both the masculine and the feminine in the plural, the plural form was only coded for number (as for possessive adjectives).

Unlike what is stated in Thordardottir’s conventions (2005), children’s utterances were transcribed and coded for grammatical inflections without including the original form of the productions, i.e., “je mange” was transcribed as such: “je manger/p1”.

Finally, mazes, like false starts, repetitions of the same word, revisions or stuttering, and onomatopoeias and interjections, like fillers or animal sounds, were not included in the morphemes count. Those elements were separated from the rest of the utterance with brackets. In some cases where an utterance was abandoned but correctly finished after a pause greater than 250 ms, the production was counted as two utterances and included in the analysis and any repeated word (because of the pause) was put between parenthesis (see example 5 of Suppl. table 1). Suppl. table 1 includes examples of morpho-syntactic transcriptions.

**Supplemental table 5.** Examples of transcribed utterances coded for grammatical inflections

|  |  |  |
| --- | --- | --- |
| 1. | Orthograph | tiens voilà l ton trophée d'amour |
|  | Morpho-syntax | tenir/p2/m1 voilà (l) ton/ga trophée de amour‘Here goes l your love trophey’ |
| 2. | Orthograph | regarde il a il y a un s un squelette quelette dessus |
|  | Morpho-syntax | regarder/p2/m1 (il a) avoir/p3 (un s) un squelette (quelette) dessus‘Look there is there is a s a skeleton keleton above’ |
| 3. | Orthograph | des ch des chiens |
|  | Morpho-syntax | (des ch) des chien/pln‘D dogs’ |
| 4. | Orthograph | mais c'est quoi |
|  | Morpho-syntax | mais ce être/p3 quoi‘But what is it’ |
| 5. | Orthograph | euh quand la voiture [250-ms pause] est usée |
|  | Morpho-syntax | (euh) quand la voiture [250-ms pause] être/p3 user/t1/ga‘Uh when the car is used’ |

*Stepwise comparisons of multilevel linear regressions on acoustical measures of speech*

**Supplementary table 6.** Results of reported stepwise comparisons of multilevel linear regressions at the syllable level.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Model name** | **Nested model** | **Fixed effects added** |  | **Random Effects** | **Model fit** | **LRT Test against nested** |
|  | **Subjects** | **Syllable structure** | **AIC** | **BIC** | **LL** | **df** | **χ²** |
|  *Dependent variable = duration of V, CV, VC and CVC syllables (in ms)* |
| Null | - | - |  | Intercepts | Intercepts | -39395 | -39361 | 19702 |  |  |
| Syllable duration | Null | Group |  | “ | “ | -39397 | -39354 | 19703 | 1 | 3.54 . |

\*\*\* *p* < .001, \*\* *p* < .01, \* *p* < .05, . p < .1

**Supplemental table 7.** Results of reported stepwise comparisons of multilevel linear regressions at the vowel level.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Model name** | **Nested model** | **Fixed effects added** |  | **Random Effects** | **Model fit** | **LRT Test against nested** |
|  | **Subjects** | **Vowel type** | **AIC** | **BIC** | **LL** | **df** | **χ²** |
|  *Dependent variable = log-transformed median F0* |
| Null | - | - |  | Intercepts | Intercepts | 2867.4 | 2896.8 | -1429.7 |  |  |
| Median F0 | Null | Group |  | “ | “ | 2869.2 | 2896.8 | -1429.6 | 1 | 0.19 |
| *Dependent variable = F0 range* |
| Null | - | - |  | Intercepts | Intercepts | 60250 | 60280 | -30121 |  |  |
| F0 range | Null | Group |  | “ | “ | 60252 | 60289 | -30121 | 1 | 0.001 |
| *Dependent variable = jitter* |
| Null | - | - |  | Intercepts | Intercepts | -57663 | -57634 | 28836 |  |  |
| Jitter | Null | Group |  | “ | “ | -57661 | -57624 | 28836 | 1 | 0.01 |
| *Dependent variable = shimmer* |
| Null | - | - |  | Intercepts | Intercepts | -31048 | -31019 | 15528 |  |  |
| Shimmer | Null | Group |  | “ | “ | -31047 | -31010 | 15528 | 1 | 0.61 |
| *Dependent variable = F1-F2 dispersion index (on z-scored F1 and F2 values)* |
| Null | - | - |  | Intercepts | Intercepts | 25078 | 25108 | -12535 |  |  |
| F1-F2 dispersion index | Null | Group |  | “ | “ | 25079 | 25116 | -12534 | 1 | 0.97 |

\*\*\* *p* < .001, \*\* *p* < .01, \* *p* < .05, . p < .1