

## Supplementary Materials

The results of Experiment 1 suggest that 12-month-old infants possess the resources to grasp a morphosyntactic regularity even when exposed to little variation and few exemplars of it. However, an alternative explanation not invoking sensitivity to structure may hold that infants only reacted to local mismatches between syllable positions. By definition, non-words have either the A or the C syllables different to those of words or rule-words: if they did not, they would also be rule-words (or words). Thus, infants may have reacted to a partial mismatch between the rule-words or the familiarization words and the non-words. According to this explanation, instead of representing abstract classes of items defined by syllables in the initial and final positions, infants may have only extracted words during the familiarization phase. Then, in the test phase, they may have only monitored one single syllable (the first, the second, or the last) and noticed that the syllable in that position differed between non-words and familiarization words. This may have caused longer listening time for the non-words.

Because of the construction of the material in Streams A and B, Experiment 1 excludes that infants responded by only monitoring differences between the test items and either the second or third syllable of the familiarization words. Indeed, two of the non-words in Stream A had structure CBA' and two had structure AC'B. Thus, in two of the four non-words, the initial syllable was identical to that of words (and hence of rule-words). In the other two non-words, the initial syllable was not identical to that of words, but the middle syllable was. Therefore, if infants only monitored the first syllable of the test items, looking for partial matches between the test items and their memories of the familiarization words, they should react only to the non-words whose initial syllable did not match the familiarization words. They should also find no difference between those non-words with initial syllables identical to the familiarization words and the rule-words. This argument predicts that infants should look longer at non-words than rule-words only for the two non-words with a first

syllable different from the first syllable of the words. By the same argument, if infants monitored only the second syllable of the test items and looked for differences with familiarization words in that position, they should only look longer at the non-words with a middle syllable different from the middle syllable of the words. We tested whether there was any difference between the trials where infants listened to non-words sharing the first (or second) syllable with words and those in which they did not. There was no difference ( $t(15) = 0.395$ ,  $p = 0.699$ , paired  $t$ -test).

However, Experiment 1 does not exclude that infants responded by only monitoring differences in the last syllable of the test items. To control for this possibility, we ran a control Experiment. We maintained the familiarization and rule-words from Stream A of Experiment 1, but we created two novel non-words with BAC' structure. They had the last syllable identical to that of words. We replaced the two AC'B non-words with these novel non-words, so that in the test phase, two non-words shared their last syllable with the familiarization words, and two non-words shared their second syllable with them. The differential looking behavior when listening to non-words and rule-words would confirm that infants may be sensitive to the structural properties of rule-words. Instead, the absence of any difference in looking behavior between non-words sharing or not sharing their last syllables with words would exclude that the results of Experiment 1 were due to a simple monitoring of a single position in the test items.

### Participants

Sixteen infants from Italian-speaking families, aged 1;0 ( $M = 1;0.25$ ; Range = 1;0.9 - 1;1.15) with a minimum APGAR of 8 and no hearing or vision problems, were included in the analysis (7 girls). Sixteen additional infants were excluded from the analyses (12 for fussiness, and 4 because they looked longer than 65 cumulative s in more than one test trial).

### Stimuli and Procedure

Infants were familiarized with stream A of Experiment 1. After familiarization,

they listened to the same test items as in stream A, Experiment 1, except that the two non-words with AC'B structure were replaced with novel non-words having BAC' structure (see Table 3). The procedure was otherwise identical to Experiment 1A.

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### Results and discussion

A repeated measure ANOVA, with the test item type (Non-words vs. Rule-words) as a within-participant factor and the participants as a random factor, showed that infants looked longer while listening to non-words than to rule-words ( $M_{\text{Non-words}} = 8.89$  s,  $SE = 0.64$ ;  $M_{\text{Rule-words}} = 7.67$  s,  $SE = 0.68$ ,  $F(1, 15) = 7.97$ ,  $p = 0.01$ ,  $\eta_p^2 = 0.346$ ). The results replicated those of Experiment 1, with a different set of test items. To further analyze the positional explanation of our results, we also examined whether there was any difference between those trials in which infants listened to non-words with the last syllable identical to that of words and those with the middle syllable identical to that of words. As in Experiment 1, there was no difference ( $t(15) = 0.26$ ,  $p > .80$ , paired t-test). Together with the results of Experiment 1, these findings exclude that infants respond to mismatches between test items and words in familiarization in one single position.

While the results may indicate that infants are sensitive to the word-internal structure, an alternative explanation is that infants may have monitored more complex positional information, for example, by tracking multiple positional mismatches. Indeed, non-words mismatch with words in two positions, whereas rule-words mismatch with words in only one position (the middle syllable). The current experiments, as well as all other experiments in the literature which contrast words to

non-words or part-words, cannot exclude this explanation.<sup>1</sup> However, we want to point out that the sensitivity to structure does imply the detection of positional violations over structural elements. Thus, if a language is SVO, then an SOV sentence is ungrammatical. Thus, even assuming a restricted interpretation, our results minimally show that infants possess one crucial tool to analyze within-word relations (i.e., tracking of multiple positional variations), which may be their entry point into the morphosyntax of their lexicon.

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1 One way to avoid the problem of multiple positional violations (at least in token position, if not in type position) would be to break the relationship between the particular initial and final syllables in the test items, for example, asking infants to compare the AXC word and AX'C' non-words. In this case, the non-words would still maintain initial and final syllables in the same position as the words, but would be novel in the pairing of the particular initial and final syllables that compose them. This is the design adopted by Gómez (2002) and Gómez and Maye (2005). In their experiments, 12-month-olds failed to respond to a difference between AXC and AX'C' items. Infants succeeded only fairly late, between 15 and 18 months, and only when they experienced a significant variation in the middle element of three-word strings. There are advantages to this design when infants succeed. However, a failure remains ambiguous between two interpretations. Infants may fail because they do not extract nonadjacent relations, or they may fail because they compare relations not between tokens but between classes of items appearing in the first and last positions during familiarization. Endress and Bonatti (2007) showed that adults extract precisely this pattern when exposed to an AXC segmented stream. To avoid this ambiguity, we chose the method implemented here, which consisted of showing that the simple overlap of a common last syllable or a common first syllable between rule-words and non-words cannot account for infants' longer looking times to non-words -- a result which suggests that infants treat novel items having the same initial and final syllables as familiar as familiarization words. Our design can only provide indirect evidence for nonadjacent sensitivity by comparing different conditions. However, a failure is a non-ambiguous indication that infants fail to consider nonadjacent relations among within-word syllable positions, as it cannot be explained away by the abstraction of classes positionally defined.

## References

- Endress, A., & Bonatti, L. L. (2007). Rapid learning of syllable classes from a perceptually continuous speech stream. *Cognition*, *105*(2), 247-299.
- Gómez, R. L. (2002). Variability and detection of invariant structure. *Psychological Science*, *13*(5), 431-436.
- Gómez, R., & Maye, J. (2005). The developmental trajectory of nonadjacent dependency learning. *Infancy*, *7*(2), 183-206.

## Table and Figure Captions

**Table 3.** Items used to compose the familiarization stream and the test phase of the experiment reported in the Supplementary Materials. The boldface in Rule-Words and Non-Words identifies syllables that appear in the same positions as in the words of the familiarization streams. Every item is identical to those presented in Experiment 1, stream A, except for two novel non-words, which share the last syllable with some of the words of the familiarization stream.

Table 3

<b>WORDS</b> <b>(Identical To Exp. 1. Stream A)</b>	<b>RULE-WORDS</b> <b>(Identical To Exp. 1. Stream A)</b>	<b>NON-WORDS</b>
/bamuso/	/baliso/	/sogali/
/bagaso/	/bafeso/	/femuba/
/limufe/	/libafe/	/mubafe/
/ligafe/	/lisofo/	/galiso/