If you repeat your interlocutor's syntactic structure, you are likely to repeat her pronunciation, too

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Abstract

Past studies showed that in dialogue, interlocutors copy each others' behavior in various ways. Copying on one grammatical level leads to increased chances of copying on other levels as well, a so-called 'alignment boost'. The identification of specific alignment boosts offers important insights into the architecture of language comprehension and production because it highlights relations between different types of linguistic representations. We examine the possibility of a direct influence from grammar on sound with no involvement of the conceptual system. In priming experiments with non-words, we show the existence of a direct syntactic alignment boost to segmental phonology. The outcomes are of relevance to models of language processing.

1 Introduction

Past research has established beyond doubt that conversation participants frequently take over each others' structural and phonetic/phonological choices. One of the first investigations describing *syntactic* imitation was Schenkein's (1980) analysis of repetitions in burglar conversations over walkie-talkies. The phenomenon has been observed many times since, both in experimental studies and in studies of natural interactions (for an overview, see Pickering & Ferreira, 2008). Also in the area of *phonetics* and *phonology*, repetition of recently produced or perceived patterns has been widely documented, e.g., for the pronunciation of vowels and consonants, pitch accent, speech rate, and low and high boundary tones (Natale, 1975; Gregory & Hoyt, 1982; Giles, Coupland & Coupland, 1991; Pardo, 2006; Delvaux & Soquet, 2007; Nilsenová, Swerts, Houtepen & Dittrich, 2008). In the newly proposed forward model by Pickering and Garrod (2013), repetition starts during the process of language comprehension in the form of covert imitative behavior that helps the perceiver predict upcoming linguistic representations. Comprehension and production are not isolated processes, rather, they are interweaved through imitation.

The tendency to "reuse what has been used" offers rich testing grounds for theories of language architecture for two reasons: First of all, if certain representations - e.g., abstract syntactic representations that are independent of meaning and sound (Pickering & Ferreira, 2008) - are reused, it means that they form a part of the speech planning process. Second, it has been observed that the repetition can be enhanced if other representations are repeated as well, for instance, syntactic imitation gets a 'boost' from a repetition of the head verb (Branigan, Pickering, & Cleland, 2000; Branigan, Pickering, McLean & Cleland, 2007). The occurrence of such a boost has been interpreted as evidence that some, but not all, levels of representations are related in the sense of percolating activation (Pickering & Garrod, 2004), see Figure 1.

In the context of the theoretical discussion regarding the links between linguistic representations and their reuse in dialogue, the study reported here has two objectives. First, we set out to replicate in another language the results of Branigan, Pickering, and Cleland (2000) who observed a boost from repetition of a head verb on syntactic imitation. Second, we test the possibility of a syntactic boost on phonology while excluding the involvement of the lexicon, making use of two different experimental paradigms: a verb invention task and a rhyming task. To our knowledge, the (direct) effect of syntax on phonology has not been examined in the context of alignment studies.

The idea that syntax determines phonological operations has been around for some time, e.g., according to Bierwisch (1966), syntax 'feeds phonology' when syntactic output is converted into phonological output. The relation can also be illustrated with phenomena such as liaison, syntactically determined segmental duration or accent placement (Klatt, 1975; Selkirk, 1974). However, most linguistic studies appear to use suprasegmental phenomena for the argument that syntax drives phonology, e.g., segment duration and coarticulation can presumably be included under prosody given that they are related to prosodic boundaries. It could, in fact, be the case that various types of phonological segments are differently affected by the speaker's syntactic choices (Santesteban, Pickering, and McLean, 2010), nonetheless, the claim made by Pickering & Garrod's model of language processing is stronger because it presumably concerns phonology as a whole. Therefore, we expect a possible boost of syntactic repetition to occur on a segmental level as well. Any other outcome would suggest that the levels of linguistic representations postulated in the Alignment model need to be refined and, possibly, their relations to other representations revised.

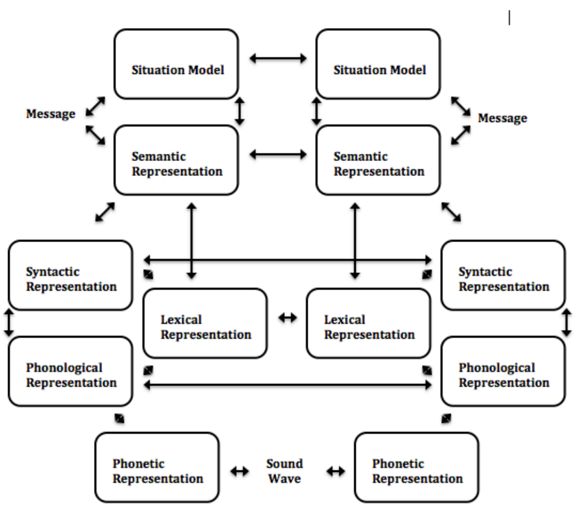

Figure 1: The Interactive Alignment Model (reproduced on the basis of Pickering & Garrod, 2004:177).

2 Current study

Below, we report the experimental methods and results of three experiments designed to test the existence of a lexical boost on syntax (Experiment 1), a syntactic boost on phoneme selection in a task involving invented verbs (Experiment 2) and a syntactic boost on rhyme pronunciation with stimuli containing nonexistent brand names (Experiment 3). In the first experiment, we sought to replicate the results of Branigan, Pickering, and Cleland (2000) for English by adapting their experimental design for Dutch. In the second and third experiment, we made use of two different experimental methods to test the link between syntax and phonology.

To analyze the data, we made use of multilevel models. In traditional ANOVAs the variance due to items and the variance due to respondents cannot be estimated simultaneously. As a consequence, the total variance is underestimated, which causes $H0$ to be rejected too easily (see Quené & Van den Bergh, 2004). To decrease the risk of type 1 errors, we applied multilevel models in the current study. Such models do allow for estimating the between item variance and the between respondent variance simultaneously. For example, in the multilevel model for experiment 1, the percentage of alignment is estimated for the boost and no boost conditions. In addition, the model allows these means to vary between items (one item may elicit more alignment than another) and between respondents (one respondent may align more frequently than another). These variances are estimated simultaneously, so in fact a cross-classified model is in operation (see Quené & Van den Bergh, 2004). The alignment percentages for the boost and no boost conditions can be compared in a contrast test (Bosker & Snijders, 1999; Goldstein, 2003), which yields a χ^2-distributed test statistic. For a formalization of this model and further explanation, we refer to Appendix 1.

3 Experiment 1

In the first experiment, we made use of the method originally due to Branigan, Pickering, and Cleland (2000), in order to replicate their study of English verb-repetition boosts on syntactic priming.

3.1 Method

Participants

Twenty-two Dutch speakers (14 female; mean age 18;8) were recruited from a Dutch University student population and received course credits for their participation.

Design

The participants were randomly assigned to two experimental conditions, with or without lexical boost (Boost and No Boost, respectively).

Materials

The participants took part in a confederate-governed task of describing 28 drawings (12 ditransitive stimuli (see Figure 2) + 16 monotransitive fillers (see Figure 3)), while being primed alternatively with a syntactic structure of the form 'ditransitive verb + direct object + prepositional indirect object (e.g., "The pirate is giving the book to the captain.") and a structure of the form 'ditransitive verb + (non-prepositional) indirect object + direct object (e.g., "The pirate is giving the captain a book."). For their description, they were asked to use the verb given under the drawing. In the condition with lexical boost, the verb was the same as the verb used in the confederates prime, in the condition without lexical boost, the verbs differed.

To balance for order effects and verb effects, in both conditions, there were 4 confederate variants with structures alternating per verb. The sentences we used were Dutch translations of the sentences employed by Branigan et al. (2000) in their picture-matching task. An experimental pilot (N=33) revealed a possible effect of the monotransitive fillers on the experimental trials; in Dutch, unlike in English, ditransitive verbs such as *geven* 'to give' or *overhandigen* 'to hand over' can be used in monotransitive constructions as well. Therefore, we adapted the fillers in such a way that they resembled the experimental trials in terms of length and syntactic complexity by including a propositional phrase (e.g., 'The boy is drawing a picture on the board', instead of the original 'The boy is drawing a picture').

Figure 2: Examples of experimental stimuli depicting ditransitive events.

Procedure

During the experimental session, the participant was seated opposite to the confederate who pretended to be a participant as well. The experimental leader was present in the same room to answer questions and make sure that the participant followed the experimental instructions. The experiment was presented as a game of describing and finding pictures, where both the correctness of the response (picture found) and the time needed to do so would be compared across conditions. The participants were explicitly told that rather than performing the task quickly, they should attempt to be as precise as possible. The output for both conditions was recorded on paper by the confederate, and the dialogue was digitally recorded with the help of MacBook computer by the experimenter. After each experimental session, the transcripts were compared to the audio recordings and corrected if necessary.

The confederate and the participant were taking turns in describing the pictures (see Figure 2), with the confederate always initiating the turn (in other words, priming the participant). The confederate picture set included full sentence descriptions of the pictures but in order to maintain the appearance of being a participant as well, the confederate pretended to be making up the descriptions on the spot. The participant was not aware of what was in the confederate set, but assumed that it resembled his/her own.

After the experimental session, the experimental leader asked both the confederate and the participant if they noticed anything unusual. Only after that did she disclose the real purpose of the experiment and the role of the confederate.

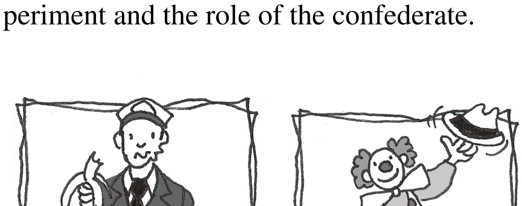

Figure 3: Examples of experimental fillers used in the confederate task in all three experiments.

Scoring

The trials in which the participant used the same syntactic construction as the confederate were scored as 1 and the trials where the participant used a different construction, be it the alternative ditransitive structure or a monotransitive one, were scored as 0.

Results

Table 1 presents the average probability of alignment for the Boost and No Boost conditions. Results show that participants aligned more often in the Boost condition than in the No Boost condition ($\chi^2 = 12.25$; df = 1; $p < 0.001$).[1] As the systematic between-person variance is estimated to be zero (see Table 1), the difference between the Boost and No Boost conditions is large as compared to the systematic differences between respondents. In comparison to the systematic differences between items, the size of the effect can be classified as medium (Cohen's $d = 0.41$).

Condition	Mean	S^2_{items}	$S^2_{persons}$
Boost	.76 (1.14)***	1.14	0
No Boost	.55 (1.55)		0

Table 1: Parameter estimates of imitation probability for the boost and no-boost condition.
Note. *** $p < .001$. For the sake of convenience, the mean alignment probabilities provided in proportions and in the Logits used for the analysis (between brackets). The variances are only provided in Logits. The item variance is estimated once, for the Boost and No Boost conditions together.

Discussion

The first experiment showed that syntactic priming received a lexical boost in the condition in which participants were using the same verb as the confederate in his/her prime (the boost condition). The result is a replication of the finding reported by Branigan, et al. (2000) for English.

4 Experiment 2

In the second experiment, we explored the effect of a syntactic boost on phonological alignment. In order to test for the relationship directly, we aimed to exclude the effects of the lexicon that is likely to facilitate phonological alignment in spontaneous data.

4.1 Method

Participants

Twenty-four speakers of Dutch (15 female; mean age 19;3) drawn from the same participant population as in Experiment 1 took part in the experiment. None of the speakers took part in the other two experiments in this study.

Design

The participants were randomly assigned to two experimental conditions, syntactic Boost and No Boost.

Materials

Participants were filling in an invented verb into a blank of the form 'NP who IO DO' (e.g., *De man die de non een appel…* "The man who…the nun an apple.") or 'NP who DO PO' (e.g., *De man die een appel aan de non…* - "The man who … an apple to the nun"). The systematic variation in the confederates verbs consisted (1) in the number of syllables (one or two) and the initial phoneme (a vowel or a consonant), see Table 2. In total, there were 24 experimental trials.

Initial Phoneme	Monosyllabic	Disyllabic
Vowel	*oeft*	*oegert*
	aapt	*eivelt*
	oot	*affelt*
	iert	*uitert*
	eift	*iemelt*
	eemt	*okkelt*
Consonant	*proest*	*manilt*
	kniert	*pippelt*
	bort	*lippert*
	vlaapt	*zachelt*
	slinkt	*poenkert*
	loept	*niesert*

Table 2: Monosyllabic and disyllabic nonwords used as primes in Experiment 2.

Procedure

Same as in Experiment 1.

Scoring

The nonsense verbs created by the participants were transcribed by the experimental leader dur-

[1] The size of an effect is often classified in relation to the standard deviation (Cohen 1988). In the kind of multi-level models that we have used, different sources of variance are modeled and so different measures for the effect size may be calculated (i.e. the effect size relative to the between-item standard deviation and the effect size relative to the between-person standard deviation).

ing the experimental session, as well as digitally recorded. The transcriptions were made in such a way as to reflect the rules of the Dutch spelling system and checked against the audio recordings first by the experimental leader and subsequently by another linguist. The confederate's and participants' nonwords were first transcribed in IPA by an independent condition-blind linguist in accordance with the mainstream Dutch phonological system (Appel et al., 2001).

We calculated the proportion of phonological alignment by comparing broad and narrow phonological transcriptions of the prime and the target. For the broad phonological comparison, we scored responses as 1 if there was at least one phoneme in the prime and in the participants' response that had an identical manner or place of articulation as the prime (again disregarding its position and excluding the $3rd$ person singular morpheme), and 0 otherwise. For the narrow phonological comparison, we scored the responses as 1 if at least one identical phoneme in the prime and in the participants' response was present (disregarding its position and the $3rd$ person singular $-t$ at the end which was present in all responses); otherwise, the response was coded as 0.

Results

Table 3 shows for the Boost and No Boost conditions the percentage of alignment, both for the broad phonological scoring system and the narrow phonological scoring system. When a broad phonological scoring system is used, we find that participants align equally often in the Boost condition and the No Boost condition (χ^2 = 0.05; df = 1; p = 0.82). However, when a narrow phonological analysis of alignment is performed, differences can be observed: participants align more often in the Boost condition than in the No Boost condition (χ^2 = 6.25; df = 1; p = 0.01; Cohen's d = 0.31).[2]

Discussion

The results of the second experiment indicate that there is a link between the syntactic and the phonological component that does not have to be mediated by the lexicon. In particular, when speakers repeat the syntactic choices of their dialogue partner, they are also more likely to align phonologically. The phonological adaptation, however, is rather subtle and, at least in this experiment, was only revealed when a narrow phonological transcription was used to score the participants' responses.

A generalization of the outcome of the experiment might be difficult, given the low ecological validity of the task used in the experimental procedure. Therefore, we conducted a third experiment in which we again tested the presence of a syntactic boost on phonology with a different task involving the pronunciation of unknown brand names for products depicted on the drawings used in the previous experiments.

Set	**Type**	**Brand**	**Set**	**Type**	**Brand**
1	filler	*Novita*	7	filler	*Teps*
	filler	*Mapri*		filler	*Fobat*
	prime	*Slent*		prime	*Prievais*
	target	*Flant*		target	*Crevi's*
2	filler	*Zilko*	8	filler	*Savin*
	filler	*Altreno*		filler	*Gikmer*
	prime	*Kedélen*		prime	*Vaik*
	target	*Hedelen*		target	*Tike*
3	filler	*Blarkin*	9	filler	*Ritrabo*
	filler	*Xepon*		filler	*Hijntes*
	prime	*Xail*		prime	*Nóreo*
	target	*Rile*		target	*Toreo*
4	filler	*Walmits*	10	filler	*Quotrepi*
	filler	*Crendum*		filler	*Jovent*
	prime	*Drend*		prime	*Bingles*
	target	*Grand*		target	*Fringles*
5	filler	*Volstar*	11	filler	*Pladow*
	filler	*Dapens*		filler	*Krepo*
	prime	*Metálogis*		prime	*Welsprie*
	target	*Protalogis*		target	*Depsprit*
6	filler	*Unalem*	12	filler	*Obitan*
	filler	*Elanit*		filler	*Lantadi*
	prime	*Zappel*		prime	*Njugels*
	target	*Qappel*		target	*Kugels*

Table 4: Brand names used as primes and fillers in Experiment 3.

5 Experiment 3

In the third experiment, we examined the direct relationship between syntax and phonology (with no intervention of the lexicon) with the help of a 'rhyming task' implemented in a design akin to the previous two experiments.

[2] An analysis of alignment on the number of syllables and the initial phoneme (vowel or consonant) showed no significant effects of the experimental manipulation.

Scoring	Condition	Mean	S^2_{items}	$S^2_{persons}$
Broad Phonetic	Boost	.78(1.24)	1.62	0
	No Boost	.77 (1.22)		0.14
Narrow Phonetic	Boost	.49(-0.04)*	1.89	0
	No Boost	.39 (-0.46)		0

Table 3: Parameter estimates of imitation probability for the boost and no-boost condition.
Note. * $p < .05$. For the sake of convenience, the mean alignment probabilities provided in proportions and in the Logits used for the analysis (between brackets). The variances are only provided in Logits. The item variance is estimated once, for the Boost and No Boost conditions together.

5.1 Method

Participants

Forty speakers of Dutch (20 female; mean age 21;7) drawn from the same participant population as in Experiment 1 and 2 took part in the experiment. None of the speakers took part in the other two experiments in this study.

Design

The participants were randomly assigned to two experimental conditions (with and without syntactic boost). The dependent variable was phonological alignment ("rhyming").

Materials

We made use of the same drawings depicting ditransitive events as in experiment 1 with the addition of a nonword "brand-name" before each object in the sentence, with 12 experimental trials and 12 fillers (see Table 4), with two different order variations. To prevent lexical priming, the head verbs used in the prime-target pairs were always non-identical. Prior to the experiment, a pretest was conducted with a different group of participants from the same population (N = 33). The goal of the pretest was to determine the preferred pronunciation of the invented brand names. In the primes used by the confederates in the subsequent experiment, we only used the non-preferred pronunciation.

Procedure

Same as in Experiment 1 and 2. In the instructions given to the participants we asked them to read the sentences under the drawings to indicate which drawing their partner should search (e.g., "The teacher is handing over the *Slent* banana to the swimmer.").

Scoring

Participants' pronunciation of the invented brand names was transcribed by two research assistants blind to condition. The responses were scored as 1 if the pronunciation rhymed with the pronunciation of the confederate and 0 otherwise.

Results

Table 5 shows the average probability of alignment for the boost and no boost conditions. Results show that participants align more often under boost conditions than under no boost conditions (χ^2 = 7.71; df = 1; $p < 0.01$; Cohen's d = 0.57).

Condition	Mean	S^2_{items}	$S^2_{persons}$
Boost	.40 (-0.39)*	0.89	0
No Boost	.28 (-0.93)		0

Table 5: Parameter estimates of imitation probability for the Boost and No Boost condition.
Note. * $p < .05$. For the sake of convenience, the mean alignment probabilities provided in proportions and in the Logits used for the analysis (between brackets). The variances are only provided in Logits. The item variance is estimated once, for the Boost and No Boost conditions together.

Discussion

The third experiment confirmed the partial finding of Experiment 2. We found that participants were more likely to use the dispreferred pronunciation of an unknown brand name if they were repeating the same syntactic structure as the confederate and the pronunciation rhymed with the confederate's immediately preceding choice.

6 General Discussion

The series of experiments reported here focused on the relations between two pairs of linguistic representations, the lexicon and syntax (Experiment 1) and syntax and phonology (Experiment 2 and 3). These relations were examined in the context of repetitions in an interactive game with alignment boosts. Earlier studies of the link between syntax and phonology, in particular the existence of *phonological* boost on syntax, offer inconclusive results. In a hallmark study, Bock (1986) reported that prime words that were semantically related to entities represented visually gave rise to active/passive constructions in which the semantically related words came first. This finding, however, was not replicated for primes that were phonologically related to words describing entities in the visual material (e.g., the prime frightening did not give rise to constructions starting with lightning). Bocks conclusion was that unlike semantics, phonology did not influence syntactic formulation. Similarly, Cleland and Pickering (2003) found no enhanced priming effect of phonological similarity on noun-phrase structure (a complex noun phrase containing a relative clause vs. a simple noun phrase). In their study, this result was contrasted with the enhanced priming effect of semantically related nouns. Again, it was taken to suggest that phonology does not appear to give a boost to syntactic alignment. A more recent study of between-language syntactic priming in constructions involving cognates, though, suggested that phonology may affect syntax at least to some extent (Bernolet, Hartsuiker, & Pickering, 2012). In particular, in a study with Dutch-English bilinguals, cognates boosted syntactic priming, while non-cognates did not. This result seems to be in line with an earlier observation by Lee and Gibbons (2007) that the preference for metrical structure (the rhythmic alternation between stressed and unstressed syllables) affects the (syntactic) decision to use a complementizer. It is also in line with the outcome of Santesteban, Pickering, and McLeans (2010) experiment showing that the use of semantically unrelated homophones boosts syntactic priming; in their experiments the effect was as strong as the effect of a lexical boost.

In sum, it appears that with respect to the direction from phonology to syntax, the relation between syntax and phonology might be more complex than the representation currently included in the Alignment model. The outcomes of the experiments reported here indicate that a similar conclusion might be drawn for the relation from phonology to syntax. Future research needs to disentangle how various types of phonological representations (segmental/suprasegmental, word-initial, accented, etc.) affect and are affected by syntactic repetition, for instance by measuring the effects of syntactic boost on accent placement.

7 Conclusion

Participants in an interactive task repeated the linguistic choices of their partners more often if they were instructed to repeat the same head verb (Experiment 1) or the same syntactic structure (Experiment 2 and 3) in the same sentences. The outcomes of the experiment suggest the existence of alignment boosts from the lexicon to syntax and from syntax to phonology. The second type of boost appears to affect various phonological segments to a different degree, which suggests that the levels of representations currently represented in the Alignment model need to be refined.

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Appendix: Multi-level models

As an example, we will elaborate on the multi-level model applied in experiment 1. In this model, the occurrence of alignment is estimated separately for the boost and no boost conditions. This is done in Logits, because the estimations concern a binomial dependent variable. In addition, between-item variance and between-person variance are allowed.

Equation A1 gives a formalization of the model applied in experiment 1. In this model, $Y_{(jk)}$ indicates whether or not participant j (j = 1, 2,. . . , 28) aligns with the confederate for item k (k = 1, 2,. . . ,14). In addition, there are two dummies (D), one for the boost conditions (D_BOOST$_{(jk)}$), and one for the no boost conditions (D_BOOST$_{(jk)}$). These dummies can be turned on if the observation matches the prescribed type. Using these dummies, two probabilities are estimated, representing the occurrence of alignment under the boost and no boost conditions (β_1 and β_2). These may vary between items (v_{0k}) and between persons (u_{1j0}, u_{2j0}).

Equation A1:

$$\text{Logit } (\text{Y}_{(jk)}) = \text{D\_BOOST}_{(jk)} \ (\beta_1 + u_{1j0}) + \text{D\_NOBOOST}_{(jk)} \ (\beta_2 + u_{2j0}) + v_{0k}.$$

The model in Equation A1 can be described as a cross-classified model (Quené & Van den Bergh, 2008), as the model accounts for each observation to be nested within items and persons at the same time. All residuals are normally distributed with an expected value of zero, and a variance of respectively $\text{S}^2{}_{u1j0}$, u_{2j0}, and $\text{S}^2{}_{v0k}$. Please note that in this model the item variance $\text{S}^2{}_{v0k}$ is estimated only once for boost and no boost conditions together. This is a constraint of the model.