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Research Article

Red and blue bananas: Time-series f0 analysis of contrastively focused noun phrases in Papuan Malay and Dutch

Constantijn Kaland [a,*], Marc Swerts [b], Nikolaus P. Himmelmann [a]

[a] Institute of Linguistics, University of Cologne, Germany
[b] Department of Communication and Cognition, Tilburg University, The Netherlands

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ABSTRACT

The prosody of Papuan Malay, spoken in the easternmost provinces of Indonesia, is not fully described and understood. The limited work available suggests that phrase prosody in this language is different from other well-studied (West-Germanic) languages. However, not much is known about possible correlates of focus marking, for which prosody is used extensively in languages like Dutch and English. To gain insight into universal and specific usages of prosody, this study reports two identical production experiments and acoustic analyses carried out for Papuan Malay and Dutch, to investigate the prosody of noun phrases in different contrastive focus conditions. Participants in the experiments described pictures with different shapes and colors using specific matrix phrases. The prosody of these descriptions was examined by time-series measures of f0 and statistically analysed using generalised additive mixed models (GAMMs). Results show that speakers of Papuan Malay do not use f0 to mark contrastively focused noun phrases, unlike Dutch speakers. The main function of f0 in Papuan Malay phrases appears to be boundary marking on the final syllable in the phrase, a function also observed in Dutch. In addition, the pre-final syllable in the Papuan Malay phrase was always marked with a rising f0, whereas in Dutch an interaction between the boundary and focus marking was found. The results are discussed in a typological perspective and provide new insights into the prosody of Papuan Malay.

1. Introduction

A core function of prosody in languages of the world is to signal the information structure of the speech signal (e.g. Ladd, 2008 ch.3, Kiigler & Calhoun, 2020). This can be done in different ways, for example by distinguishing different types of information status, i.e. new, given or contrastive, or by marking phrase boundaries. Much research investigated how exactly prosodic cues signal such forms of information structure in a specific language. A variety of prosodic strategies have been observed crosslinguistically, where it has been shown that languages may vary in their respective choice of features for such functional purposes. More generally, it also has been shown that information structuring is a function not exclusively fulfilled by prosody. For example, where one language primarily relies on pitch variation or pause insertion to mark important information, another language might have a preference for word re-ordering to do the same and the balance between the functional roles may vary in cases where they use both (e.g. Zimmermann & Fery, 2010; Biking, 2010; Kiigler & Calhoun, 2020).

Unfortunately, our insight into the role of prosody in marking information status is both limited and biased. Many theories of prosodic function are predominantly based on well-studied languages like English, but the study of other languages may well advance our understanding of prosody and may allow us to disentangle universal from language-specific properties (e.g. Gordon, 2014; Jun, 2014). This study reports a production experiment on the prosodic marking of contrastive information in Papuan Malay noun phrases (NPs). This language has been studied to some extent, but its prosody is not fully understood. Word stress has been addressed in recent studies (e.g. Kaland, 2019; Kaland, 2020; Kaland, 2021) and phrase prosodic aspects have been studied to a lesser extent (Kaland & Baumann, 2020), but aspects like focus marking have not been directly investigated. It is not a priori clear whether and how contrastive information would be prosodically marked in

* Corresponding author at: Universität zu Köln – SFB 1252, Luxemburger Straße 299, 50939 Köln, Germany.
E-mail address: ckaland@uni-koeln.de (C. Kaland).

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Papuan Malay. The small number of studies on closely related varieties such as Manado Malay and Ambonese Malay are at variance regarding this potential usage of prosody (cf. Stoel, 2007 & Maskikit-Essed & Gussenhoven, 2016), so that we do not know at present which of these patterns would generalize to Papuan Malay.

In the current paper, contrastive NPs were elicited in a picture naming task and analysed acoustically. The acoustic analysis concerned time-series analysis of f0 as a (complex) contour over the course of multiple syllables. The latter novel method has the advantage of being able to capture more fine-grained f0 movements compared to static measures. These measurements were obtained from similarly elicited utterances both from speakers of Papuan Malay and Dutch speakers for a comparative analysis.

The remainder of this section is organised as follows. Section 1.1 offers a general introduction to contrastive focus and the way the notion is interpreted in the current paper. Section 1.2 discusses the literature on contrastive focus marking in prosody from a typological perspective. Section 1.3 illustrates the prosody of focus marking in Trade Malay and other Indonesian languages, after which the research aims are formulated in Section 1.4.

1.1. Contrastive focus

It is beyond the scope of this paper to discuss the various interpretations of how contrastive focus can best be conceptualized at the syntactic or (discourse-) semantic level (see the discussion in Zimmermann & Onea, 2011). In order to illustrate the interpretation of contrastive focus in this paper, it is nevertheless important to discuss how languages mark this focus type prosodically. Many studies that addressed the relationship between information structure and prosody have distinguished different types of focus (e.g. Selkirk, 1995; Jun, 2005; Jun, 2014; Gussenhoven, 2007; Biking, 2010). It has been questioned whether contrastive focus constitutes an independent focus type within a more general distinction between broad and narrow focus (Zimmermann & Onea, 2011). That is, contrastive focus is often operationalised as involving the selection of a focused element among a limited set of alternatives. This is a feature that, for example, also applies to what has been called corrective focus. The discussion about the conceptualisation of focus types is particularly challenged by crosslinguistic evidence. That is, there is a large amount of variation within and across languages in the ways focus types are distinguished (or not). While this issue is discussed in the next section, this section continues by explaining how contrastive focus is interpreted in this paper. To this end, consider Example (1) with contrastive focus within an NP.

(1) "Yesterday I saw a red car and today I saw a BLUE car".

Imagine a speaker who has seen two differently colored cars in the last days and expresses this as in (1), with the word in contrastive focus in small caps. In a language such as English, speakers commonly produce "blue" in (1) in an acoustically more prominent way than "blue" in a context without semantic contrast, such as "I own a blue car". The acoustic prominence on "blue" in (1) therefore explicitly marks the semantic contrast with the red car seen on the previous day and implies that "car" remains prosidcally unmarked although "car" would have been marked by default if there would not have been a contrast. Studies have addressed the cognitive mechanisms behind the contrastive marking function of prosody. Commonly, prosodic marking of contrastive information in languages such as English is reported to restrict the set of contextual alternative meanings (Braun & Tagliapietra, 2010; Husband & Ferreira, 2016). For example, by emphasizing that the car is blue, the set of alternative meanings is restricted to colors, i.e. blue, not red (or any other color). Compare this interpretation to "I own a blue car", without prosodic marking of a semantic contrast. Thus, marking contrastive information prosodically is a useful way for speakers to single out one specific element among others (Chafe, 1976).

1.2. Contrastive focus crosslinguistically

The ways in which prosody marks contrastive information differs across languages. For English, studies have reported specific intonation patterns (e.g. pitch accents) that make the words referring to the contrastive information, such as blue in (1), acoustically prominent (e.g. Pierrehumbert & Hirschberg, 1990). Similar strategies are used in other West-Germanic languages such as Dutch (Hanssen, Peters, & Gussenhoven, 2008) and German (Baumann, Grice, & Steindamm, 2006). Research investigated to what extent the pitch accent that marks contrastive information is different from the one marking new information, as could be expected in autosegmental metrical accounts of intonation (e.g. Jun, 2005; Jun, 2014). It was found for Dutch that the actual shape of the produced fundamental frequency (f0) contour was not unique for contrastive information, but at the perceptual level contrastive intonation sounded more prominent than the non-contrastive (new) one (Krahmer & Swerts, 2001). In addition, isolated accents sounded more prominent than accents in a phrase context (among other pitch accents). The perceived prominence in a contrastive intonation pattern originated from the unusual location of the f0 peak, i.e. because of its non-default (unexpected) position (the adjective). That is, in the West-Germanic languages just mentioned, it is possible to deaccent the word that would be accented by default (the syntactic head of the NP; e.g. *car* in (1)) and shift the pitch accent to the word that refers to the contrastive information (e.g. *blue* in (1)).

The above mentioned West-Germanic way of prosodically marking contrastive information is different from the one used in most Romance languages. Languages like Italian (Swerts, Krahmer, & Avesani, 2002), Romanian (Swerts, 2007), Canadian French (Swerts & Vroomen, 2015), or Spanish (Cruttenden, 1993) have the tendency to resist a change from the default location of the pitch accent, at least within syntactic phrases (see Ladd, 2008), as complete NPs can be deaccented in those languages as well. French sometimes allows an accent shift, although to a lesser extent than West-Germanic languages (Rasier & Hiligsmann, 2007). These results are often attributed to an underlying difference between West-Germanic and Romance languages in terms of plasticity of the intonation contour (Vallduvi, 1991). This view explains how these languages differ in the way focus and prominence go together (i.e. the 'togetherness' of focus and prominence; Vallduvi, 1991, p.295). West-Germanic languages such as English have a plastic intonation contour in the sense that it

is shaped by the demands of focus, i.e. by making the focused word in an NP acoustically more prominent. Romance languages such as Catalan, on the other hand, are non-plastic in that the intonation contour does not change and that there is a stronger tendency for a focused constituent to be made syntactically prominent by means of word order variation. Note that in most of the above mentioned studies, contrastive focus was elicited using NPs describing pictures in a naming task. Such tasks are particularly useful to control the type of contrasts (e.g. shape or color contrasts eliciting noun or adjective focus respectively). It need to be acknowledged that this is a specific type of narrow focus within a constituent (NP) and does not necessarily generalize to other types of contrastive focus, e.g. between constituents. It has been shown, for example, that in Korean between-constituent contrastive focus is marked prosodically, by realigning prosodic phrase boundaries (Kember, Choi, Yu, & Cutler, 2021) while there is no contrastive focus marking within constituents (Lee et al., 2015).

Particularly relevant in this context is the word order variation observed in NPs between languages that by default place the adjective pre-nominally (e.g. West-Germanic languages) or post-nominally (e.g. Romance languages). There seems to be a correspondence in these language families between the extent to which they use pre-nominal adjectives and the extent to which they use accent shifts for focus marking in NPs. Again, French shows that these differences are gradient rather than strictly categorical, as it allows pre-nominal adjectives to some extent. Although beyond the scope of the current study, this also posits the question of whether this correlation is unique to the above mentioned languages, or whether there are potentially universal restrictions that NP word order variation puts on focus intonation, as further discussed in Section 4.4.

Some languages make use of different prosodic means to mark contrastive information (e.g. Kiigler & Calhoun, 2020). Note that these strategies might affect not just the focus constituent such as (part of) an NP, but a larger part of the utterance. For example, in Bengali both the f0 shape and compression of the f0 range post-focally are typically used in corrective or surprise information (Khan, 2014), a context that is semantically most similar to the type of contrastive information described in this study. Post-focal compression is indeed widespread across languages of the Indo-European, Uralic, Altaic, Afroasiatic, Dravidian, Kartvelian and Eskimo-Aleut language families, i.e. not the Austronesian language family to which Papuan Malay belongs (Xu, 2011; Xu, Chen, & Wang, 2012). Another prosodic means is to insert a phrase boundary before or after the focused word(s), i.e. “dephrasing” (Jun, 1993; Ladd, 2008), as found in Chĩchewa (Kanerva, 1990) and Korean (Jun & Lee, 1998). It has furthermore been found that in Swedish some speakers used a pause to set off the focused word (Heldner & Strangert, 2001). Note that both f0 marking and boundary insertion are two means to achieve that the focused words stand out acoustically and are perceived as prominent. Even closely related languages can differ in the weight they give to each of these means (e.g. see Van Heuven & Kaland (2017) for phrase boundary marking strategies in Dutch and German and Burdin et al. (2015) for focus marking differences between four typologically unrelated languages). Languages such as Chĩchewa are categorised under *boundary languages* in a typological account of focus marking (Biking, 2010). Boundary languages are distinguished from *edge languages* (such as Hungarian), where the focused word(s) appear at the left or right edge of the phrase (Fery, 2013). Note that in edge languages, the essential strategy to mark focus is non-prosodic. Indeed, the literature reports on a number of languages in which prosody is not used at all to mark (contrastive) focus, such as Wolof (Rialland & Robert, 2001) Gúrúntúm (Hartmann & Zimmermann, 2009) and Chickasaw (Gordon, 2008). In these languages the focused word(s) are preceded by or followed by lexical markers respectively. In a large number of languages, however, both prosodic and non-prosodic means are used for focus marking (cf. *mixed languages* in Biking, 2010). For example, in Catalan (Prieto, 2014), both the pitch accent type as well as left edge positioning of the focused word(s) can mark contrastive information. See also Elordieta (2007) for an overview of the different marking strategies across languages.

1.3. Prosodic marking of contrastive information in Trade Malay and Indonesian

Given the interest of the current study in Papuan Malay, this section discusses the ways in which contrastive information is marked in a set of languages found in different areas of Indonesia, even when these are sometimes typologically different. Due to trading between Malaysia and the eastern part of the Indonesian archipelago the Malay language arrived first in the Moluccas, probably around the 14th century (Kluge, 2017). Although it is not exactly clear which languages contributed to the emergence of Papuan Malay, it is generally claimed that Malay spread from the Moluccas to other parts of Eastern Indonesia (and beyond, see Adelaar, 2004), such as the current Indonesian provinces Papua and West Papua. This spreading was partially the result of the Dutch colonial rule enforcing Malay in education and administration. Currently, Papuan Malay is spoken by at least a million people (probably more) and adopted many loanwords from Indonesian, the language used in the public domain (Kluge, 2017). In the current section, therefore, prosodic marking of (contrastively) focused information in both (Trade) Malay varieties as well as Indonesian are discussed in order to formulate hypotheses about Papuan Malay. Fig. 1 shows the (Trade) Malay varieties that are discussed in the following subsections and spoken in Indonesia and Malaysia. Note that Standard Indonesian is found across Indonesia and for pragmatic reasons located in its capital (Jakarta), whereas Betawi Malay is the Jakartan variety of Trade Malay that evolved during the Dutch colonial era.

1.3.1. Eastern Indonesian Trade Malay varieties

An autosegmental metrical analysis of Manado Malay intonation (Stoel, 2005; Stoel, 2007), based mainly on elicited question–answer dyads, reported prosodic highlighting of four different constituents: predicate focus (Fig. 2a), subject focus (Fig. 2b), object focus and verb focus. In all instances, focus is marked by a rising pitch accent on the syntactic head of the constituent which always occurs at the right edge of a phonological phrase (Stoel, 2007). This phonological phrase corresponds roughly to the intermediate phrase in the analy-

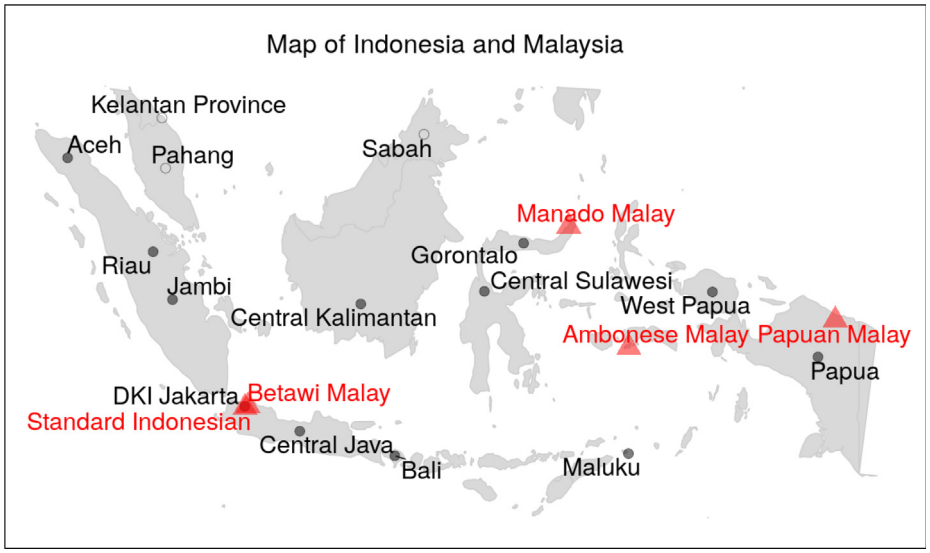


Fig. 1. Map showing provinces and major governmental districts of Indonesia (filled dots) and Malaysia (open dots), and the geographical location (coordinates from Hammarstrom et al., 2021) of the (Trade) Malay varieties spoken in this area and discussed in the current paper (red triangles). Singapore Malay is. not shown here. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

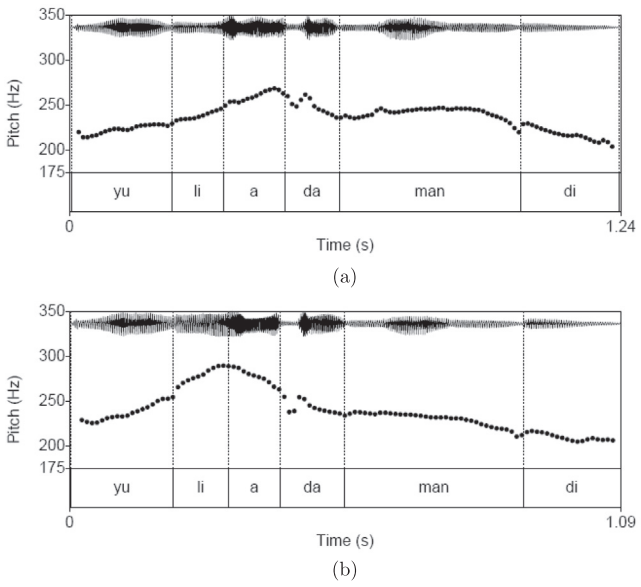


Fig. 2. Manado Malay phrase *Yulia da mandi* 'Yulia is bathing' with (a) predicate focus (H* on *man*) and (b) subject focus (H* on *li*). In both phrases *Yulia* forms a PhP; either with H edge tone (a) or with L edge tone (b). Taken from Stoel (2007).

ses presented in Jun (2005) and Jun (2014). In general, only one phonological phrase in an intonational phrase may include a pitch accent and this phrase typically appears at the end of the intonational phrase. There is no possibility of putting contrastive focus on a constituent that does not occur at the right edge of a phonological phrase. Hence in the Manado Malay equivalent of an utterance such as (1) the pitch accent occurs on the word for "car" irrespective of whether noun or adjective contrast with a preceding word (Stoel, 2007, p. 121). Phrases with corrective focus have been elicited for Ambonese Malay (Maskikit-Essed & Gussenhoven, 2016, Fig. 3). Apart from a wider pitch range compared to some of the elicited neutral declarative focus phrases, no systematic prosodic marking of focus was observed in Ambonese Malay f0 contours or duration.

It should furthermore be noted that in Manado discourse particles are frequently used for information structuring purposes (Stoel, 2007). These particles often occur at the right edge of the phrase and do not receive a pitch accent, but might be produced with a boundary tone. The particle *kwa?* is reported to express a contrast and to sound prominent (Stoel, 2007, p. 130–131). It is plausible therefore that semantic contrasts of the type in (1) are also expressed by non-prosodic means in Manado Malay. In as much as focus was discussed in the limited number of descriptions of other Trade Malay varieties, the use of focus particles in various phrase positions was also reported for Larantuka Malay (Paauw, 2009, p.156).

1.3.2. Betawi Malay

In Betawi Malay, the f0 contour of phrase final words (objects) in focus were analysed (Van Heuven, Roosman, & Van Zanten, 2008). They all showed a rise-fall compared to a largely flat contour in the non-focused counterparts. Considerable variability was reported on the f0 timing, such that the accent-lending f0 movements could be located on either the pre-final, final or on both of these syllables. The loose alignment of the f0 movements was partially explained by the lack of word stress in Betawi. That is, there is no syllable with which the phrase final movement aligns, which seems to indicate free variation in accent placement at the surface. Further analysis showed that the accent could shift to the final syllable either when schwa occurred in the pre-final syllable or because the word occurred in phrase final location. As these two (post-lexical) shifts are optional, the default accent location was reported to be the pre-final syllable in the phrase.

1.3.3. Singapore Malay

Intricate f0 timing differences were reported for focus types in Singapore Malay (Hamzah & German, 2014). Specifically, the last syllable of the focused constituent would be produced

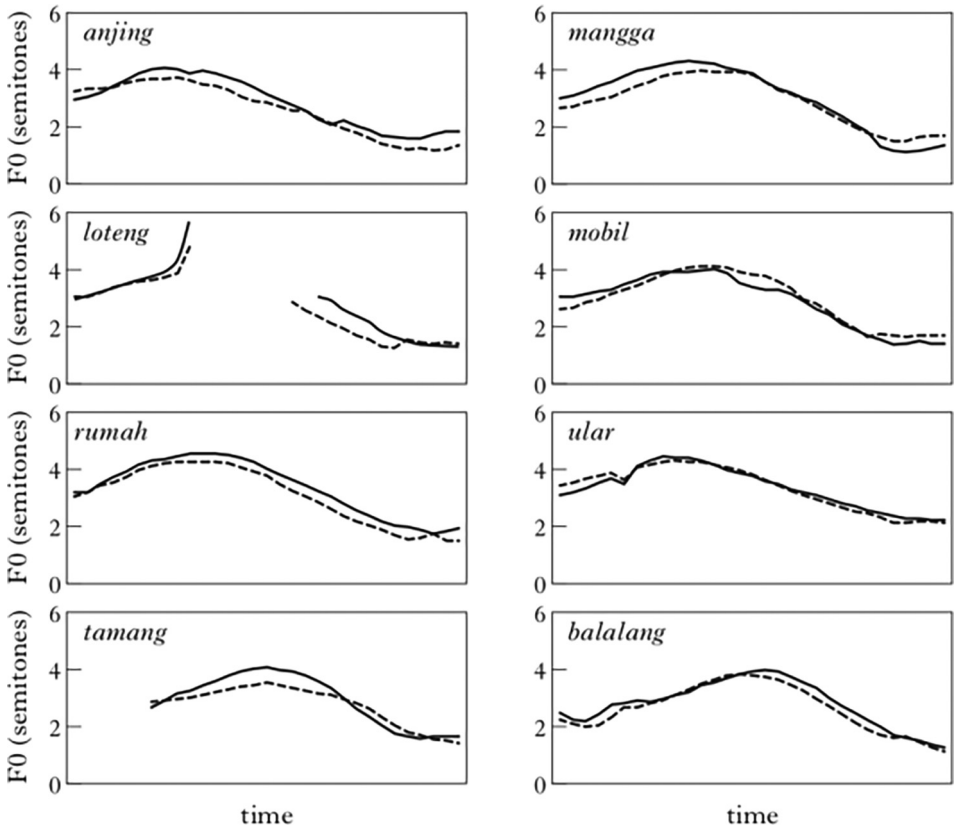


Fig. 3. Ambonese Malay words in sentence-final position with corrective declarative focus (solid lines) and neutral declarative focus (dashed lines). Normalised time scale. Taken from Maskikit-Essed and Gussenhoven (2016).

with an earlier f0 peak in a subject-focus context compared to an all-focus (broad focus) context. Similar early peak alignments were found for VP-focus contexts. As for prosodic phrasing, the default final high tone of an accentual phrase (AP) in Singapore Malay was reported to be replaced by a high tone signaling focus. However, from the examples it remains unclear whether the phonological distinction between the default AP-final high tone and the focus AP-final high tone is reflected in its acoustic realisation or perceived prominence (Hamzah & German, 2014).

1.3.4. Indonesian

A series of perception experiments on Standard Indonesian (as spoken in Pekanbaru, Riau province) investigated whether focus and boundary marking had separate effects on prosody (Ebing & Van Heuven, 1997). Both prosodic functions were manipulated using read versions of the arithmetic expressions 2 x (3 + 5) and (2 × 3) + 5, in which the main prosodic boundary is produced after the first numeral (2) or after the second numeral (3), respectively. The arithmetic expressions were designed such that focus occurred on either the first, second or third numeral depending on the context provided by a preceding question. The recordings were then presented to listeners who had the task to first judge the location of the boundary by forced choice, and then indicate which word was the most prominent in the expression. Results indicated a strong tendency for listeners to perceive the pre-boundary numeral as the most prominent and an overall bias to perceive boundaries after the second numeral. Acoustic analysis of the stimuli showed an additive effect of focus and boundary, in that syllables to which both functions applied had relatively large f0 excursions. Thus, when syllables fulfilled just one of these functions, either in focus or in a pre-boundary position, much smaller f0 movements were observed. Although listeners did not make apparent use of these cues in the task, speakers in the recordings differentiated between focus and boundaries on the second syllable of the numerals by means of early or late falling f0 movements respectively (Ebing & Van Heuven, 1997, Table 4). The latter finding led to the conclusion that Indonesian prosody does not effectively distinguish focus and boundary marking. In another perception study (Van Heuven & Faust, 2009), metalinguistic narrow focus contrasts were presented in a forced choice task to native speakers of Dutch and Indonesian learners of Dutch. Note that metalinguistic contrasts were reported to be marked by f0 in Italian (Ladd, 2008), despite the strong tendency to resist accent shifts (see also Section 1.2). The stimuli were Dutch productions of a coherent contrast (e.g. “I did not say cofFER, I said cofFIN”) and an incoherent contrast for which the focused (i.e. accented) syllable was not the minimally different one, e.g.: “I did not say cofFER, I said COFfin”. Participants had the task to select the preferred, most coherent, among the two contrasts. Results showed that, above chance level, Dutch listeners choose the coherent version, whereas the Indonesian learners of Dutch all performed around chance level. A small improvement was observed for Indonesian learners who had resided longer in The Netherlands and subsequently had more time to learn the way Dutch speakers mark metalinguistic contrasts.

However, the improvement failed to result in above chance level performance. The findings were interpreted as evidence for the insensitivity of Indonesian speakers for metalinguistic narrow focus. In this respect, it is important to recall the corrective focus contexts used in Van Heuven and Faust, 2009, where both the corrected (i.e. antecedent) and the correction (i.e. target) were marked prosodically. An f0 movement in the antecedent could then act as "forward-reference" (Swerts, 2007), just as boundary tones that signal coherence between successive phrases (see Pierrehumbert & Hirschberg, 1990, p. 305). The comparison with boundary tones is crucial here, as in Singapore Malay (Hamzah & German, 2014) it was found that boundary tones could be replaced by focus marking tones. As discussed above, boundary marking and focus might not be straightforward to disentangle in Indonesian (Ebing & Van Heuven, 1997).

1.3.5. Implications for the current study

A number of conclusions can be drawn from the literature that give rise to new research questions addressed in this study. Primarily, the current body of literature on Trade Malay varieties lacks a systematic study of (contrastive) focus. That is, the focus contexts that have been elicited have only been described morpho-syntactically in grammars (e.g. Larantuka Malay, Paauw, 2009), investigated acoustically based on a limited number of elicited examples and speakers (e.g. Ambonese, Maskikit-Essed & Gussenhoven, 2016) or only investigated by visual inspection of f0 contours (Manado Malay; Stoel, 2007).

Secondarily, there is considerable prosodic variation to be expected on two levels. First, f0 has been shown to be highly variable in Betawi Malay (Van Heuven et al., 2008), potentially masking the prosodic structure in focus contexts. Particularly relevant here is the position of the f0 movement in the phrase. Final phrase positions appear to play an important role in the realisation of these movements, not only in Betawi, but also in Trade Malay varieties. In this regard, it is important to note that in Dutch, the potential effects of phrase position on contrastive focus marking in prosody have been largely unexplored (e.g. Krahmer & Swerts, 2001), a point which is further discussed in Section 4.1. Second, wester Austronesian languages, including the Trade Malay varieties, show considerable variation on how prosodic aspects such as word stress and pitch accents are analysed (cf. Stoel, 2007; Maskikit-Essed & Gussenhoven, 2016; Kaland, 2021), an observation that is not surprising considering the vast archipelago where these languages are spoken and the methodological differences between the studies. It is particularly challenging at this stage in the research to prosodically typologise these languages (note their absence in e.g. Biking, 2010 & Jun, 2014). The question remains, therefore, which functions f0 movements actually have and whether there is a common feature shared among the Trade Malay varieties, as suggested in Kaufman and Himmelmann, n.d..

Finally, it has to be noted that many languages of the world not only use prosody to mark contrast. Often, syntactic phrasing, lexical items or morphology can be used as well. Papuan Malay has a repertoire of focus adverbs that in most contexts "highlight information and signal some kind of restriction, thereby adding emphasis to an utterance" (Kluge, 2017, p. 271). The use of focus adverbs may thus eliminate or diminish the necessity to rely on prosody as the only marker of contrastive focus. Nevertheless, prosody could still be used as an additional means, such as in languages that combine prosodic and non-prosodic means (e.g. Catalan; Prieto, 2014).

To sum up, given the variation in Trade Malay varieties, it remains unclear how f0 is used in Papuan Malay contrastive contexts and predictions remain speculative. To clarify this issue, results need to be embedded in the context of research on languages that has contributed much to our understanding of prosodic marking. A crosslinguistic comparison highlights the extent to which the (Papuan) Malay prosodic strategies are unique and where they might show similarities with well known (West-Germanic) languages. A systematic comparative study is therefore needed and further outlined in the next subsection.

1.4. Research aims

The aim of the current study is to acoustically investigate f0 contours in utterances with contrastive information. This advances our knowledge of Papuan Malay prosody and further completes the prosodic typology of contrastive focus. The current study compares Papuan Malay with Dutch, a language for which contrastive focus has been documented and studied extensively (see Section 1.2). This comparison allows us to interpret the Papuan Malay results in a wider context and, importantly, separate potential task-related effects from actual linguistic differences between the languages. That is, the comparison with Dutch also serves as a guarantee that the experimental task can in principle induce contrastive focus marking. To this end, the same production task was carried out for both languages with systematic control over the phrase structure. Three main variables were investigated and concern focus, phrase position and phrase type.

As for focus, object descriptions consisting of a noun and an adjective (NPs such as in (1), see Section 2.2 for the Papuan Malay and Dutch versions) were compared in focused and unfocused contexts. Concerning phrase position, the NPs were elicited in phrase medial and phrase final position to investigate whether this makes any differences for focus marking, as suggested for (Trade) Malay varieties discussed above. As for phrase type, semantic contrasts were elicited by means of an antecedent and a target phrase. These are defined following (1), where "yesterday I saw a red car" is considered the antecedent of the contrastive target phrase "today I saw a BLUE car". Both antecedent and target were taken into account in the current study to investigate how phrasing could interact with focus marking. Of particular relevance to contrastive information such as in (1) is the availability of the entire contrast to the speaker before planning its production. Thus, speakers could theoretically produce marked f0 movements as early as the antecedent phrase, not necessarily on the target phrase alone. It is therefore important to account for the theoretical possibility of forward-looking contrastive focus markers in Papuan Malay. The current study does this by comparing the prosody of both phrase types involved in the semantic contrast (i.e. the antecedent and the target).

Collected utterances were acoustically analysed for f0 using generalised additive mixed modelling (GAMM). GAMM pro-

vides a way of analysing f0 as a continuous curve using time series data, which reflects the nature of this acoustic correlate better than, for example, measures taken in small time domains such as single syllables or at specific time points (e.g. f0 peak). This method is further explained in the following section. F0 measures were chosen as it has been recurrently shown in the literature that f0 is a particularly suitable correlate of phrase prosody as its perceptual domain generally exceeds the word (e.g. Gordon, 2014). In addition, (autosegmental) intonational modelling has generally focused on f0 as a primary prosodic correlate to make generalisations about the prosody-meaning interface (e.g. Pierrehumbert & Hirschberg, 1990).

2. Methodology

A production task was carried out in order to elicit phrases with semantic contrasts and to investigate whether these contrasts are prosodically marked in Papuan Malay and Dutch. This was done by presenting a pair of minimally different pictures to participants, who described them using specific matrix sentences.

2.1. Participants

As for Papuan Malay, a total of 24 participants carried out the task; 13 males and 11 females (mean age: 23.6 years, age range: 18–33 years). Most of them also mastered a second language, usually Standard Indonesian and/or the language of (one of) their parents; e.g. Javanese (5), Biak (8), Ternate (1), Waropen (1), Kupang (1), Mpur (1), Buton (1), Bugis (1), Tetum (1). Regardless of their second language, all participants were native speaker of Papuan Malay, i.e. they had learned it from birth and used it in daily life. Their second language was therefore not considered for the purposes of this study.

As for Dutch, a total of 23 participants carried out the task; 2 males and 21 females (mean age: 20.4 years, age range: 18–23 years). They were all native speakers of Dutch with some command of English.

Before the experiment, all participants (Papuan Malay and Dutch) were asked whether they had speech problems or color blindness in a questionnaire. None of them indicated they had either of those. Participation in the experiment was part of a course requirement for all participants (PMY: students of English or Indonesian language and literature, NLD: Communication Science respectively). They were recruited with the help of their teacher or institute employees (Papuan Malay) or via an online recruitment system (Dutch). None of the participants reported having difficulties performing the task.

2.2. Design

Picture pairs were selected on the basis of minimal differences in shape or color. The selected words referring to the shapes and colors in either Papuan Malay or Dutch consisted of two syllables to obtain a homogeneous set of NPs (Table 1). As for Papuan Malay, shapes and colors were selected only when they occurred as native words in Kluge, 2017, to avoid the use of loanwords. Note that in Dutch color words are inflected when used as adjectives in an NP with definite article, e.g. *blauw* becomes the bisyllabic *blauwe* (blue). As for the shapes, ten nouns were chosen that referred to common objects, animals or persons. The shape words were chosen such that they had the same syllable structure in either language. This was done to facilitate the comparison of f0 contours on phrases with similar segmental makeup. As for the colors, five words were selected on the basis of the Papuan Malay colors listed in Kluge, 2017. The identical set of colors was used for Dutch. Table 1 provides an overview of the words referring to the shapes and Table 2 provides an overview of the words referring to the colors in either language. For the purpose of the experiment black and white are considered colors.

Table 1
Overview of Papuan Malay (left) and Dutch (right) words (and English glosses) referring to the shapes used in the production experiment.

Papuan Malay		Dutch	
babi	pig	kano	canoe
gunung	mountain	robot	robot
kapak	axe	satan	satan
kucing	cat	python	python
liling	candle	haring	herring
pisang	banana	radar	radar
tangang	hand/arm	lichaam	body
tete	grandfather	sofa	sofa
tangga	ladder	tosti	toast
sapi	cow	limo	lemonade

The picture pairs were designed in such a way that the difference between the two pictures in one pair concerned either the shape (noun focus) or the color (adjective focus). In addition, pairs were created in which the pictures differed in both shape and color (neutral focus). The neutral focus pairs were added as a baseline condition and to avoid that there was a minimal contrast in all picture pairs, which could have revealed the purpose of the experiment. Table 3 shows examples of all focus conditions in both languages.

In total, 25 picture pairs were created (ten shape contrasts, ten color contrasts and five neutral focus). The two pictures that formed a pair were displayed in such a way that one occurred on the left side of the screen (antecedent) and the other on the right side of the screen (target), see Fig. 4. Participants were instructed to use one of two matrix sentences to describe the pictures such that the NP referring to the pictures occurred in sentence final (2-a) or sentence medial (2-b) position. This was done to ensure that the semantic contrast was salient and that both antecedent phrase (ANT) and target phrase (TAR) were produced within one utterance (see Example (2-a) and (2-b)). Describing semantic contrasts that span two successive utterances could lead to the use of an invariable list intonation, in particular when the matrix sentence is repeated. It also has been shown before that contrasts are

Table 2
Overview of Papuan Malay (left) and Dutch (right) words and their English glosses referring to the colors used in the production experiment.

Papuan Malay	Dutch	English gloss
hitam	zwart	black
puti	wit	white
mera	rood	red
hijow	groen	green
biru	blauw	blue

Table 3
Examples of the three focus conditions in Papuan Malay and Dutch as obtained by the picture pairs displayed on either side of the participants' screen.

Language	Left side picture	Right side picture	Focus
Papuan Malay	babi hitam	babi puti	adjective
	gunung mera	kapak mera	noun
	kucing hijow	liling biru	neutral
Dutch	zwarte kano	witte kano	adjective
	rode robot	rode satan	noun
	groene python	blauwe haring	neutral

marked more clearly when the contrasting elements occur within a sentence, rather than across sentence boundaries (Swerts, 2007). Participants were instructed to always describe the shape and the color of either picture.

(2) a. Di sebla kiri saya liat [ANT], dang di sebla kanang saya liat [TAR].

Aan de linkerkant zie ik [ANT], maar aan de rechterkant zie ik [TAR].

On the left side I see [ANT], but on the right side I see [TAR].

b. Saya liat [ANT] di sebla kiri, dang saya liat [TAR] di sebla kanang.

Ik zie [ANT] aan de linkerkant, maar ik zie [TAR] aan de rechterkant.

I see [ANT] on the left side, but I see [TAR] on the right side.

The 25 pictures pairs were presented twice; once in the first part of the experiment and once in the second part of the experiment. In each part, the pairs were presented in a different randomized order, which was again different for each participant. The matrix sentences were used equally often in either part of the experiment, such that one half of the participants used (2-a) in the first part and (2-b) in the second part and the other half of the participants used (2-b) in the first part and (2-a) in the second part. This was done to balance out potential effects of presentation order. The words in Table 1 and Table 2 were used equally often to avoid word biases. That is, each noun was used five times and each adjective was used ten times.

2.3. Procedure

The production experiment was designed using OpenSesame (Mathot, Schreij, & Theeuwes, 2012). The experiment consisted of a script written in the programming language Python (Van Rossum & De Boer, 1991) and pictures displaying the combination of shapes and colors (Table 1 and Table 2). For each picture pair, the script generated a screen with the two pictures on either side (Fig. 4). On top of the screen, a written version of the matrix sentence was displayed. Each picture pair was displayed for seven seconds after which the next pair was displayed automatically. Before the start of the experiment participants received oral and written instructions about the course of the task. Participants were instructed to switch off personal mobile devices during the entire experiment. Then, they sat down in front of a computer and completed two subsequent parts of the experiment. First, they received instructions on the screen about their task. To familiarize themselves with the task, participants completed a practice round consisting of five picture pairs. At the end of the practice round participants were asked whether they felt they needed to practice more or whether they were ready to start the actual experiment. All participants indicated that they were ready to start the actual experiment after the first five practice stimuli. Second, when participants ended the practice session the actual experiment started. Participants took a short break after the first part of experiment, after which they were instructed to use a different matrix sentence ((2-a) and (2-b)). The experiment lasted approximately 20 min. Participants were instructed to correct themselves when they noticed mispronunciations or errors (this happened up to two times per participant). The speech of each participant was recorded and saved on a computer as a wave-file. The Papuan Malay recordings were made at the Centre of Language Documentation at the Universitas Papua, Manokwari, Indonesia. The Dutch recordings were made at the DCI Lab at Tilburg University, Tilburg, The Netherlands. For all recordings participants wore a head-mounted

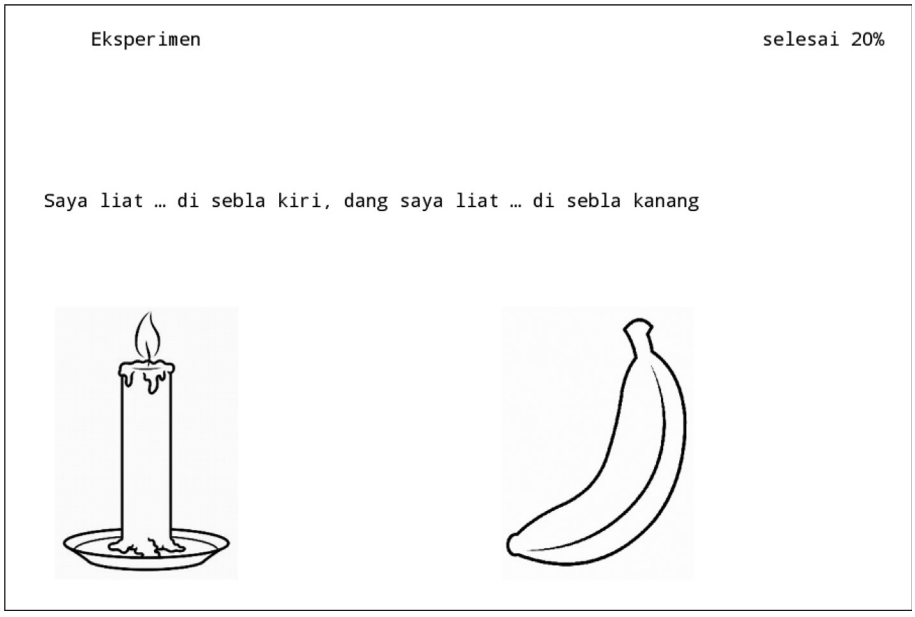


Fig. 4. Example screen capture of a picture pair in the production task (Papuan Malay, ANT: "liling puti" (white candle), TAR: "pisang puti" (white banana), noun contrast, phrase-medial).

microphone connected to the computer on which the experiment was run.

2.4. Acoustic analysis

All references to the pictures (henceforth NPs) in the recorded wave-files were annotated on the syllable- and word-level (2 syllables per word, 4 words per stimulus, 50 stimuli per participant: $N = 9600$ syllables in Papuan Malay and $N = 9200$ syllables in Dutch). This was done by trained annotators who were familiar with the language and its syllabification. Syllables produced with irregularities were not taken into account for further analysis. Common irregularities included descriptions using the wrong word to refer to the shape or color, hesitations or corrections within the word, inaudible speech or background noise. If a speaker had noticed to have made an error (e.g. mispronunciation), and then repeated the whole sentence correctly, that utterance would still be included in the acoustic analyses. After removing erroneous cases, 9010 Papuan Malay syllables and 8473 Dutch syllables were left for acoustic analysis. The acoustic analysis was carried out in Praat (Boersma & Weenink, 2019). 20 f0 measures per syllable were taken (mean syllable duration: 197.37 ms for Papuan Malay and 192.96 ms for Dutch) using the standard (advanced) pitch settings and correcting for octave jumps. The semitone scale was used for the f0 measures, to take into account speaker differences in overall f0 level (i.e. due to gender). The timestamps of these 20 measures were determined by maintaining equal intervals between each measure. For example, f0 measurements would be taken every 10 ms for a syllable with a duration of 200 ms, and every 5 ms for a syllable with a duration of 100 ms, with the first measure taken at the left syllable boundary.

2.5. Statistical analysis

The f0 measures were analysed in generalized additive mixed models (GAMMs) using the packages "mgcv" (Wood, 2017) and "itsadug" (Van Rij, Wieling, Baayen, & Van Rijn, 2017) in R (R Core Team, 2019; R Studio Team, 2019). GAMMs (Lin & Zhang, 1999) are particularly useful for time-series data and do not assume linear relationships between response and predictor(s). This makes GAMMs the preferred method for analysing f0 as a contour (i.e. over time), which is a continuous curve that can only partially be captured by static measures such as mean f0 or f0 range.

The f0 measures were numbered from 1 to 80, such that each series of 80 measures corresponded to either the antecedent or the target NP (four syllables * 20 measures per NP). In this way, one continuous f0 contour per NP could be obtained, yielding 2362 contours for Papuan Malay and 2263 contours for Dutch. Note that the number of contours was affected by the syllables that were removed due to irregularities.

In time-series analyses of f0, autocorrelation in the model residuals is often high and could be problematic for significance testing with GAMMs (Baayen, van Rij, de Cat, & Wood, 2016). This was accounted for in the current analysis in three ways. First, the number of f0 measures per syllable was reduced to 10 by taking every second measure of the collected 20 measurement points per syllable. Reducing the number of measurements allows less local variation in the contour, which could arise from f0 perturbations such as the ones following plosives. In addition, the smoothing applied by the GAMM is more accurate without potential local f0 perturbations. With 10 measurements per syllable, however, overall rising or falling movements can still be accurately modelled. Second, a random smooth by contour was added to the GAMM, which accounted for the variation between the individual contours (e.g. as the result of speaker differences) and supersedes random smooths by subject or by items due to the higher number of levels (see below). In order to reduce the computational cost of the model, a random sample of 10% of the contours (236 levels for Papuan Malay and 226 levels for Dutch) was taken for the random smooth. The random smooth adjusts the predictor in a nonlinear way, i.e. it includes both random intercepts and random slopes. Third, an autoregressive model (AR1) was added to the GAMMs used for the difference smooths (see below). An AR1 model accounts for the fact that two adjacent measurement points are correlated (autocorrelation) and so will be the residuals of the model, which biases the computation of confidence intervals and *p*-values. The AR1 model included a correlation coefficient (*rho*) to control for (part of) the residual autocorrelation as computed using the `acf()` function in the R "stats" package (R Core Team, 2019): $\rho = 0.37$ for the Papuan Malay model and $\rho = 0.22$ for the Dutch model. As can be seen in Fig. 5, including the AR1 term reduced the residual autocorrelation, especially at lag 1.

In the full model for either language, f0 in semitones was the response and the interaction between the predictors focus (three levels: neutral, noun, adjective), phrase position (two levels: medial, final) and phrase type (two levels: antecedent, target) added as parametric term. The interaction variable was also added to form a by-factor smooth which models a separate contour for each combination of the predictors. In addition, a random smooth by contour was added (236 levels for Papuan Malay and 226 levels for Dutch). Both smooth terms included the measurement point (numbered 1 to 80) as variable to allow smoothing over time. To allow for significance testing using model comparisons (see below), the smoothing parameter estimation method was set to maximum likelihood (ML).

To determine whether f0 contours were significantly different between any of the levels of the predictors, two methods were used. First, model comparisons were performed between the full model (as described above) and a model in which one of the predictors was left out from the parametric term and the smooth term (either focus, phrase position or phrase type; totalling three comparisons, see Table 4). The model comparisons could be compared to testing a main effect of each predictor. Second, difference smooths for all minimally different combinations of all three predictors (see Table 5) were plotted with a 95% confidence interval (*se* = 1.96). The difference smooths are comparable to post hoc pairwise comparisons in more traditional analyses. Thus, the difference plots provide a visualisation of the intervals at which the compared f0 contours were significantly different (i.e. where the confidence interval did not overlap an f0 difference of 0). Note that difference plots for which significance intervals were shorter than three measurement points (corresponding to less than

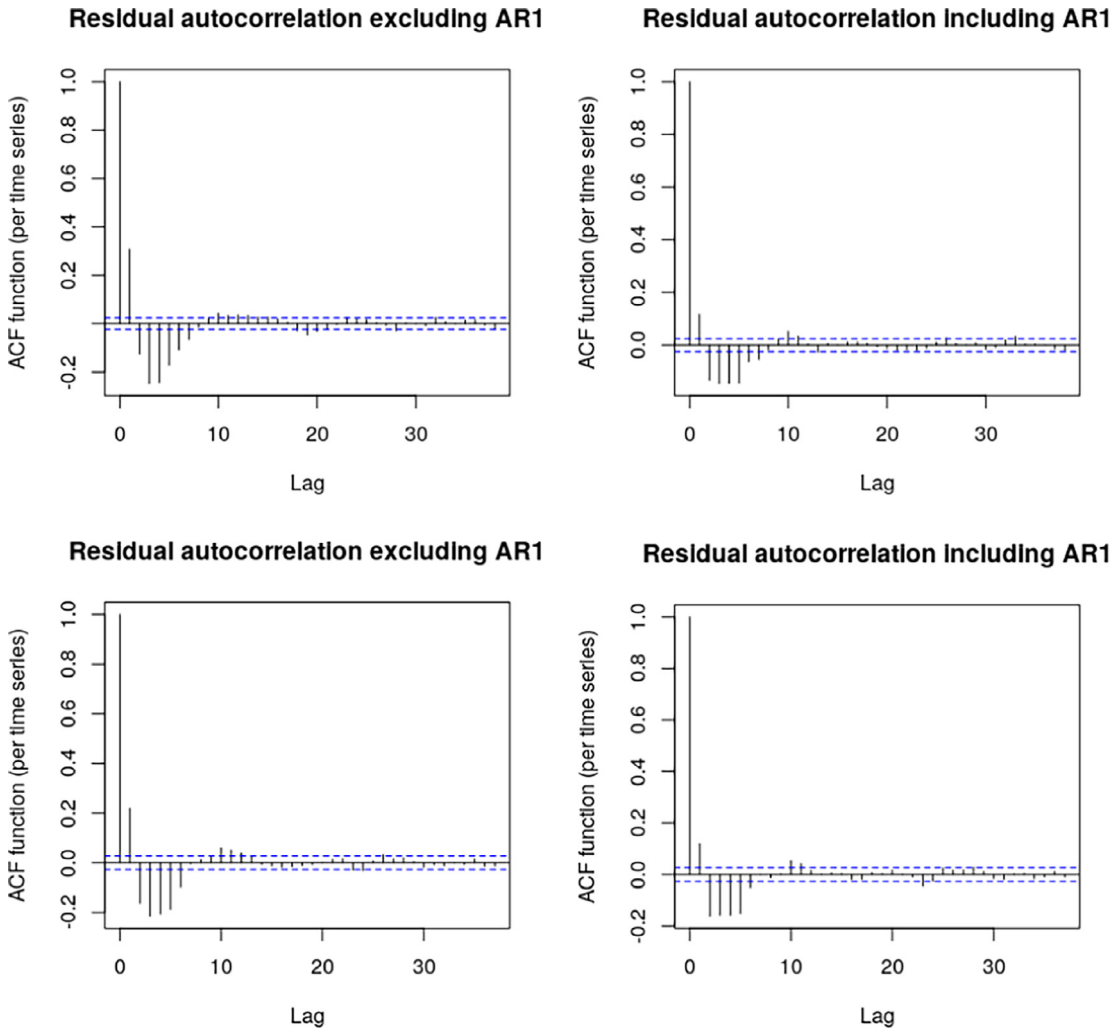


Fig. 5. Autocorrelation in the residuals of the full model for Papuan Malay (top) and Dutch (bottom) excluding AR1 model (left) and including AR1 model (right).

Table 4
Results of the comparisons with the full model, showing the maximum likelihood (ML) score difference between the models, estimated degrees of freedom (Edf) and the p-value based on a chi-square test (*p*).

Predictor	Comp. model to full model	Papuan Malay			Dutch		
		ML diff.	Edf	*p*	ML diff.	Edf	*p*
focus	phr. position * phr. type	6.50	14	n.s.	63.27	14	<.001
phr. position	focus * phr. type	31.85	20	<.001	76.91	20	<.001
phr. type	focus *phr.position	118.78	20	<.001	43.53	20	<.001

30 ms) are omitted in the results section. These short intervals span the length of a segment at most and were therefore assumed of minor or no importance at all for the overall assessment of f0 contours as markers of focus. This was the case for two difference plots concerning the Dutch contours (see Table 5).

The data, models and annotated scripts are made available as supplementary material: https://doi.org/10.17605/OSF.IO/YA4UR.

3. Results

The model comparisons (Table 4) for Papuan Malay showed significant differences when either the predictor phrase position or phrase type was left out. As for the predictor focus no significant differences were found. The model comparisons for Dutch showed that all three predictors had a significant effect on the model when left out.

The difference smooths showed where exactly the significant differences between the tested levels of the predictors were found (Table 5 and Fig. 8 and Fig. 7). As for focus, only the Dutch results showed significant differences (panel a. NLD to c.NLD). These three panels all concerned focus differences found in target phrases. That is, the significant differences were found mostly in the second syllable of the noun (approximately measurement points 60–80) and in phrase medial position also within the first syllable of the adjective (approx. points 0–20; a.NLD).

Table 5
Overview of difference plots for Papuan Malay (PMY) and Dutch (NLD) for all minimally different level combinations of the predictors focus (ntr, noun, adj), phrase position (med, fin) and phrase type (ant, tar). Capitals indicate relevant comparison.

Predictor	Difference smooth			Papuan Malay		Dutch	
				Sign. differences (interval)	Panel	Sign. differences (interval)	Panel
Focus	NTR.med.ant	-	NOUN.med.ant	n.s.	-	n.s.	-
	NTR.fin.ant	-	NOUN.fin.ant	n.s.	-	n.s.	-
	NTR.med.tar	-	NOUN.med.tar	n.s.	-	2.00 – 4.36	-
	NTR.fin.tar	-	NOUN.fin.tar	n.s.	-	n.s.	-
	NOUN.med.ant	-	ADJ.med.ant	n.s.	-	n.s.	-
	NOUN.fin.ant	-	ADJ.fin.ant	n.s.	-	n.s.	-
	NOUN.med.tar	-	ADJ.med.tar	n.s.	-	2.00 – 10.67/ 54.00 – 69.76	a.NLD
	NOUN.fin.tar	-	ADJ.fin.tar	n.s.	-	66.61 – 75.27	b.NLD
	ADJ.med.ant	-	NTR.med.ant	n.s.	-	n.s.	-
	ADJ.fin.ant	-	NTR.fin.ant	n.s.	-	n.s.	-
	ADJ.med.tar	-	NTR.med.tar	n.s.	-	n.s.	-
	ADJ.fin.tar	-	NTR.fin.tar	n.s.	-	n.s.	-
Phrase position	noun.MED.ant	-	noun.FIN.ant	n.s.	-	n.s.	-
	noun.MED.tar	-	noun.FIN.tar	72.91 – 78.42	a.PMY	2.00 – 8.30/ 57.94 – 72.12	d.NLD
	adj.MED.ant	-	adj.FIN.ant	n.s.	-	n.s.	-
	adj.MED.tar	-	adj.FIN.tar	65.03 – 80.00	b.PMY	73.70 – 76.06	-
	ntr.MED.ant	-	ntr.FIN.ant	76.85 – 80.00	c.PMY	n.s.	-
	ntr.MED.tar	-	ntr.FIN.tar	n.s.	-	n.s.	-
Phrase type	noun.med.ANT	-	noun.med.TAR	n.s.	-	n.s.	-
	noun.fin.ANT	-	noun.fin.TAR	65.03 – 80.00	d.PMY	n.s.	-
	adj.med.ANT	-	adj.med.TAR	n.s.	-	2.00 – 7.52	e.NLD
	adj.fin.ANT	-	adj.fin.TAR	65.82–80.00	e.PMY	47.70 – 54.79	f.NLD
	ntr.med.ANT	-	ntr.med.TAR	n.s.	-	n.s.	-
	ntr.fin.ANT	-	ntr.fin.TAR	68.97 – 80.00	f.PMY	29.58–74.48	g.NLD

As for phrase position, three difference smooths for Papuan Malay (a.PMY to c.PMY) showed significant difference in the final syllable of the NP (approx. points 60–80). That is, the final syllables of NPs produced phrase medially in target phrase had a significantly higher f0 than those syllables produced phrase finally, regardless of whether the focus was on the noun or adjective. A small exception was found for neutral focus in antecedent phrases (c.PMY), where the f0 in final part of the NP of was higher when produced phrase finally than when produced phrase medially. As for Dutch, phrase medially produced target NPs had a higher f0, particularly in the first syllable of the adjective (approx. points 0–20) and the final syllable of the noun (approx. points 60–80) when the noun was in focus, see panel d.NLD.

With regard to phrase type, the Papuan Malay difference smooths showed significant differences in the final syllable of the NP (approx. points 60–80) produced phrase finally such that regardless of focus condition the f0 was higher in antecedent phrases than in target phrases (d.PMY to – f.PMY). In Dutch, antecedent phrases with adjective focus also had an overall higher f0, with significant differences found either in the first syllable of the adjective (approx. points 0–20, e.NLD) when produced phrase medially, the first syllable of the noun (approx. points 40–60, f.NLD) when produced phrase finally. For neutral focus, a larger region showed a higher f0 in antecedent phrases than in target phrases, particularly the final part of the adjective (approx. points 20–40) and most of the noun (approx. points 40–80), see panel g.NLD.

In the Appendix Figs. 9–11 and Figs. 12–14 show individual examples of the target NPs produced in the different conditions, including a spectrogram, f0 contour (white dots), waveform and annotation. Note that the modelling (Fig. 6a and 6b) shows larger f0 differences due to rescaling and smoothing (i.e. random smooth by contour). Therefore, the modeled patterns do not always match the individual contours.

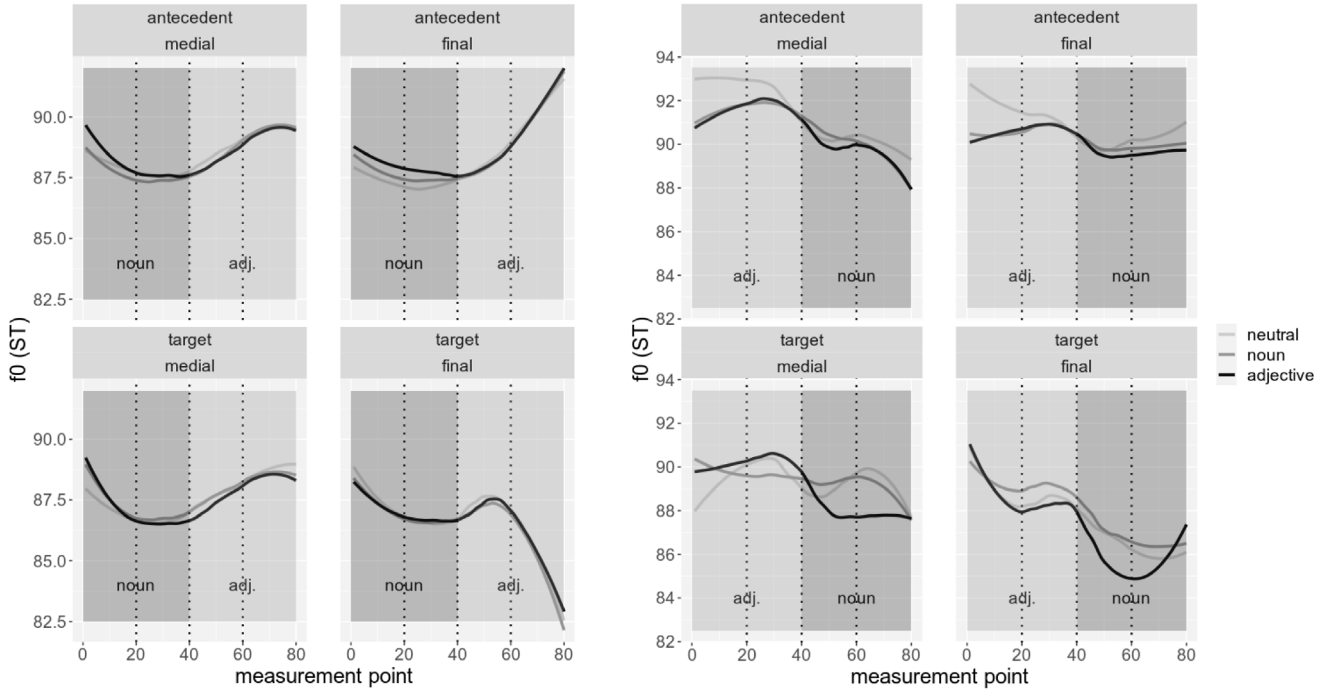
The model comparisons (Table 4) for Papuan Malay showed significant differences when either the predictor phrase position or phrase type was left out. As for the predictor focus no significant differences were found. The model comparisons for Dutch showed that all three predictors had a significant effect on the model when left out.

The difference smooths showed where exactly the significant differences between the tested levels of the predictors were found (Table 5 and Fig. 8). As for focus, only the Dutch results showed significant differences (panel a.NLD to c. NLD). These three panels all concerned focus differences found in target phrases. That is, the significant differences were found mostly in the second syllable of the noun (approx. points 60–80) and in phrase medial position also within the first syllable of the adjective (approx. points 0–20; a.NLD).

As for phrase position, three difference smooths for Papuan Malay (a.PMY to c.PMY) showed significant difference in the final syllable of the NP (approx. points 60–80). That is, the final syllables of NPs produced phrase medially in target phrase had a significantly higher f0 than those syllables produced phrase finally, regardless of whether the focus was on the noun or adjective. A small exception was found for neutral focus in antecedent phrases (c.PMY), where the f0 in the final part of the NP of was higher when produced phrase finally than when produced phrase medially. As for Dutch, phrase medially produced target NPs had a higher f0, particularly in the first syllable of the adjective (approx. points 0–20) and the final syllable of the noun (approx. points 60–80) when the noun was in focus, see panel d.NLD.

4. Discussion and conclusion

The acoustic analyses of f0 have provided markedly different results for Papuan Malay and Dutch prosody in contrastive focus contexts, while results related to phrase position and



(a) Papuan Malay (b) Dutch

Fig. 6. Smooth plots of the f0 contours (ST) in the different focus conditions, phrase positions and phrase types. Dotted lines indicate syllable boundaries.

phrase type are more similar across the languages. This section discusses the results of each variable under investigation (focus, phrase position and phrase type) and offers a more general discussion and conclusion in the final subsection. Particular attention is given to the interpretation of phrase-final (boundary) tones in Papuan Malay (Section 4.4).

4.1. Contrastive focus

Neither the model comparisons nor the difference plots showed no significant differences in the Papuan Malay f0 contours between any of the focus conditions. Nor did we find any evidence for post-focal compression in this language, which confirms the prediction in Xu, 2011. For Dutch, both the model comparisons and the difference plots revealed significant differences in the f0 contours related to focus. Focus particles are more commonly used in Papuan Malay than in Dutch. However, this difference was not relevant to the stimulus materials as they were the most plausible productions given the task in either language and designed with the help of native speakers. We therefore interpret the focus results as reflecting a genuine linguistic difference. In addition, not all of the Dutch focus results have been reported elsewhere in the literature. Therefore, the remainder of this subsection discusses them more in-depth.

The difference plots for Dutch show significant differences in several regions, most notably in the final syllable of the noun (approx. points 60–80). Although it was expected for the first (stressed) syllable of the noun to have a higher f0 when the noun was in focus, this effect only showed in phrase medial position (panel a.NLD). In phrase final position, the second syllable of the noun had a significantly lower f0 when the noun was in focus than when the adjective was in focus (b.NLD). It should be noted that the latter effect concerned an unstressed syllable. When considering the stressed syllable of the noun, although statistically insignificant, the f0 is higher for noun focus than for adjective focus (b.NLD). The significant effects are only found in target phrases, confirming that in Dutch the contrastive focus concerns backward prosodic marking, similar to the example in (1). This further leads to the observation that adjective focus and noun focus are realised differently in Dutch and that there appears to be an interaction with phrase position. Although this observation did not directly follow from the goals set for this study (Section 1.4), they are worth exploring more in the following.

Phrase medially, focus is realised by a sustained (flat) f0 on the word that is not in focus (i.e. deaccenting; Fig. 6b, b, bottom left). Phrase finally, however, a final fall on the noun can be observed in all focus conditions. The difference between noun and adjective focus is less clear from the f0 contours in this phrase position. The main difference between phrase final adjective focus and phrase final noun focus appears to be the lower fall on the noun for the former and an overall higher f0 on the noun for the latter. To our knowledge, the effect of phrase position on the realisation of Dutch contrastive intonation contours has not been documented before. That is, in comparable picture naming tasks (e.g. Krahmer & Swerts, 2001; Swerts et al., 2002) there was no systematic control over the position of the NPs in the participants' utterances. In Swerts (2007), the contrastive NPs were systematically varied between subject and object position, corresponding to phrase initial and phrase final position respectively in both Dutch and Romanian. The accent distributions were quantified by counts of where the main accent was perceived (i.e. on the adjective or on the noun), and no differences in the shape of the contrastive accent in either syntactic position was reported. No effect of

syntactic position was found on the location of the pitch accent in the NP for either language.

This brings up a second observation that provides further insight into how deaccentuation is achieved in Dutch. The effect of phrase position in the current study can be explained by assuming an interaction between the contrastive pitch accent and the phrase final low boundary tone. Due to the low boundary tone on the final syllable of the noun an extra low f0 is needed to deaccent the noun in the case of adjective focus. This result as well as the lack of effect of syntactic position in Swerts (2007) hint at the conclusion that the perceived prominence pattern for adjective focus in either phrase position is the same (i.e. adjective is the most prominent word in the NP), despite the contour being realised differently.

4.2. Phrase position

Apart from the effect of phrase position found for Papuan Malay and Dutch in the model comparison (Table 3), the difference plots for both languages indicate that the main difference between phrase medial positions and phrase final positions is found in the final syllable(s) of the NP. Generally, an overall higher f0 is found in phrase medial positions than in phrase final positions (note the small exception in panel c.PMY). It seems therefore that the f0 movements in these positions correlate with whether the phrase is still continuing (medial) or has ended (final). Note that in both Papuan Malay and Dutch the final syllable of the NP has a particularly low f0 in phrase final positions in target phrases (Fig. 7 and Fig. 8). The effect of phrase position cannot be entirely seen as separate from the difference between antecedent and target phrases. Thus, the marking of continuation versus finality applies to the difference between the respective phrase positions as well as to the difference between the phrase types, as further discussed in the next paragraph.

4.3. Phrase type

The overall f0 level was lower in target phrases than in antecedent phrases in both Papuan Malay and Dutch (Fig. 3a and 3b). These observations are likely to be the result of the natural decrease in subglottal pressure over the course of an utterance (Breckenridge, 1977). In addition, the final syllable of the NP in either language showed a clear fall when produced in final position in target phrases. This position marked the end of the utterance in a single stimulus and can therefore be seen as a boundary tone indicating finality. For Papuan Malay a straight fall can be observed on the final syllable, whereas in Dutch the movement resembles a fall-rise, where the rise appears to be a recovering reflex of the different degrees of steepness of the fall due to focus marking, as discussed in Section 4.2.

Systematic marking of continuation (antecedent phrases) and finality (target phrases) was found in either language on the final syllable of the NP. The former was indicated by a rising f0, whereas the latter was indicated by a falling f0. The use of f0 in this way reflects the way phrases are delimited by f0 in many languages of the world, referred to as boundary tones in autosegmental analyses (Jun, 2005; Jun, 2014), which are seen as independent of potential focus marking pitch accents (see also Swerts & Zerbian (2010) for similar results comparing Zulu and English).

4.4. General discussion and conclusion

The current investigation did not find acoustic evidence for contrastive focus marking in Papuan Malay prosody. For Dutch, however, the flat f0 found in unfocused words supports the literature that reports deaccenting in this type of utterances (e.g. Krahmer & Swerts, 2001). A crucial distinction made in this study concerns the position of the NP within the matrix phrase, i.e. medial or final. This distinction reveals that in Dutch, boundary tones do interact with the f0 contour in contrastive conditions. That is, phrase finality is indicated by a fall on the final word in the NP (the noun in Dutch), see Fig. 6b, b, bottom right. Focus marking in these phrase final positions appears to be realised by means of varying the steepness of the fall on the noun, with steeper falls associated with deaccentuation (adjective focus) and shallow falls with accentuation (noun focus and neutral focus). On the final adjective, more subtle effects are visible, which could be interpreted as a downstepped accent on focused adjectives. Note that the absence of a phrase-final fall, i.e. in phrase-medial targets, leads to different focus realisations that are more equally clear across both adjective and noun.

This study reconfirms what has been shown by a large number of existing studies; the way prosody marks focus differs largely between languages (e.g. Jun, 2005; Jun, 2014), whereas phrase boundaries are marked across (all) languages (e.g. Himmelmann, Sandler, Strunk, & Unterladstetter, 2018). As the investigation of focus is limited to contrastive NPs in this study, an elaborate discussion of the origins of crosslinguistic focus marking differences in prosody falls beyond its scope. However, one difference between Papuan Malay and Dutch should be discussed further in an attempt to explain the observed differences in wider context. This difference concerns NP word order. Foremost, it should be acknowledged that this difference essentially caused the experimental tasks carried out for either language to be not identical. We nevertheless assume to have reached a methodological optimum, as an attempt to make participants of one of the languages use a different word order in order to match the other language would have comprised the naturalness of the utterances. It is thus interesting that Papuan Malay positions the color words post-nominally, just like most Romance languages do and the majority of languages in the world (Dryer, 2018). Based on cognitive studies, the next paragraph provides further speculation on why NP word order might constrain prosodic focus marking.

It is known that color adjectives in object descriptions are used more frequently in languages where they occur pre-nominally than in languages where they occur post-nominally, and the word order crucially affects the identification process by listeners, see Rubio-Fernandez (2016) and Rubio-Fernandez, Mollica, and Jara-Ettinger (2018) comparing English and Spanish. This difference has been explained as the result of incremental speech production and perception (e.g. Pechmann, 1989). For speakers, pre-nominal adjectives are an efficient way to communicate visually salient (e.g. contrastive) properties such as color immediately, i.e. before the

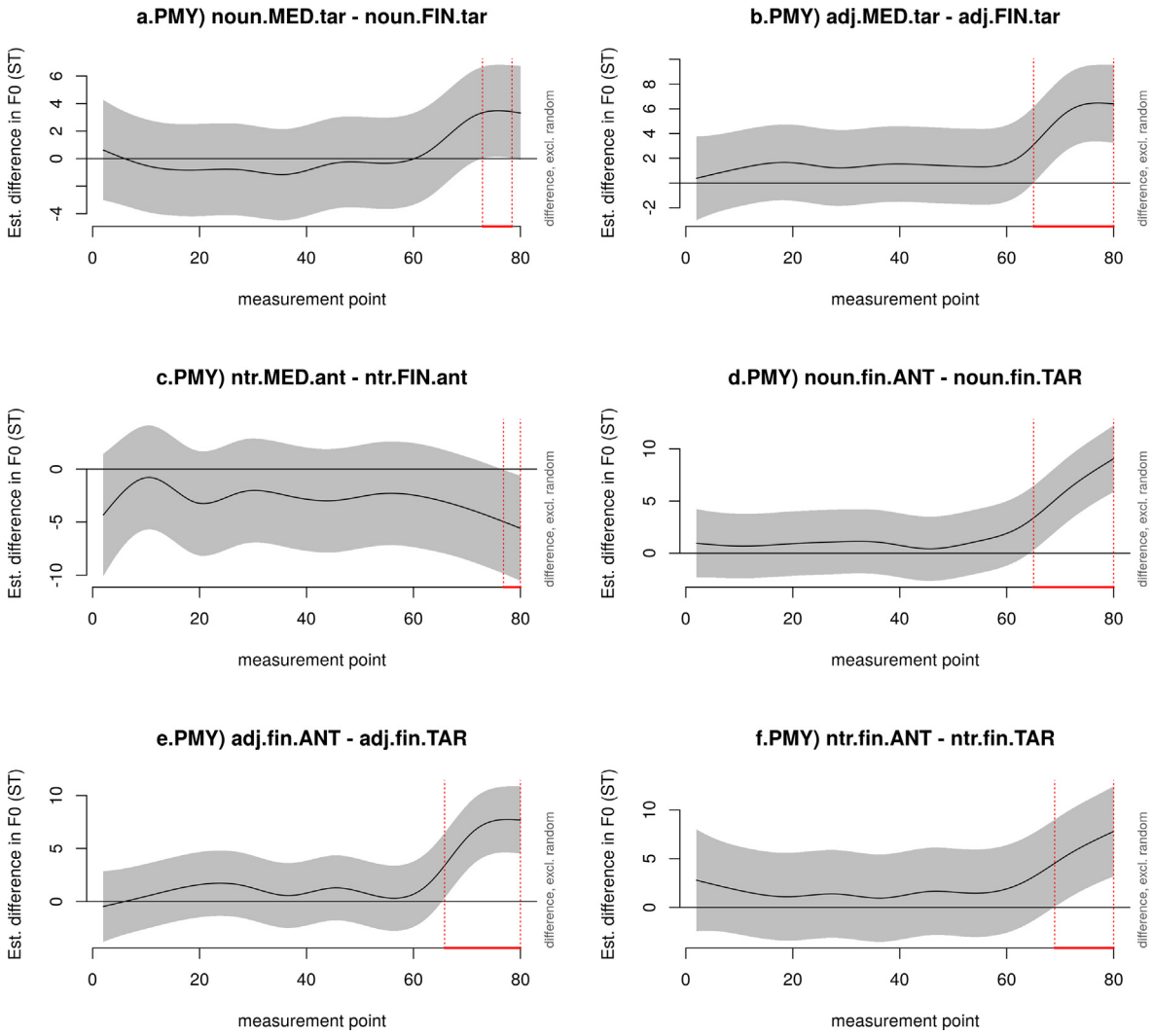


Fig. 7. Difference plots for Papuan Malay showing intervals (red dotted lines) where the compared predictor levels (in capitals) showed significant differences corresponding to Table 5.

shape of the object (noun) has been produced. In turn, listeners benefit from hearing the most salient properties first in order to identify the described object. Under this view, the same cognitive mechanisms of (visual) salience apply to both speakers and listeners (Rubio-Fernandez, 2016). Although there is to our knowledge no direct study on the extent to which these cognitive mechanisms affect the production and perception of prosody, this possibility cannot be ruled out. We speculate that NP word order could affect the immediacy with which salient properties are communicated. That is, given that post-nominal color adjectives are less often used, consistent prosodic marking post-nominally is presumably less likely too. Subsequently, it can be expected that languages with post-nominal adjectives using prosodic marking in this position are far less common. To our knowledge, only Paraguayan Guaraní was shown to mark contrastive focus within NPs on post-nominal adjectives (Burdin et al., 2015). This could be explained by the assumption that post-nominal f0 movements marking crucial information to identify an object are not immediate enough to match the incremental processes of the speaker or listener. Although the current results are compatible with this speculative explanation, more research addressing the cognitive mechanisms behind prosodic marking in (NP) word production and perception in more diverse languages would be needed to confirm it. In particular languages in which the prosodic head is consistently marked (i.e. head- and head/edge-languages in Jun (2014)) need to be further researched. The extent to which NP word order alone indeed predicts prosody, also needs particular investigation. Crosslinguistically, the ordering of the head (e.g. noun) relative to its dependent(s) (e.g. adjective) in a phrase tends be harmonic (either head-dependent(s) or dependent(s)-head) across different types of syntactic phrases (Culbertson, Franck, Braquet, Barrera Navarro, & Arnon, 2020). It is therefore plausible that this ordering impacts the way intonation and phrasing are related in a structural way within and across languages. However, recall in this respect Manado Malay, where numerals (unlike adjectives) precede nouns and are not accented (Stoel, 2007, ex. 7).

It should also be noted that word order variation might be just one of the factors contributing to the differences in prosody between Papuan Malay and Dutch observed in this study. It is likely that these languages also differ in their general prosodic structure, such as differences between word level and phrase level prosody. In Dutch, pitch accents are realised on stressed

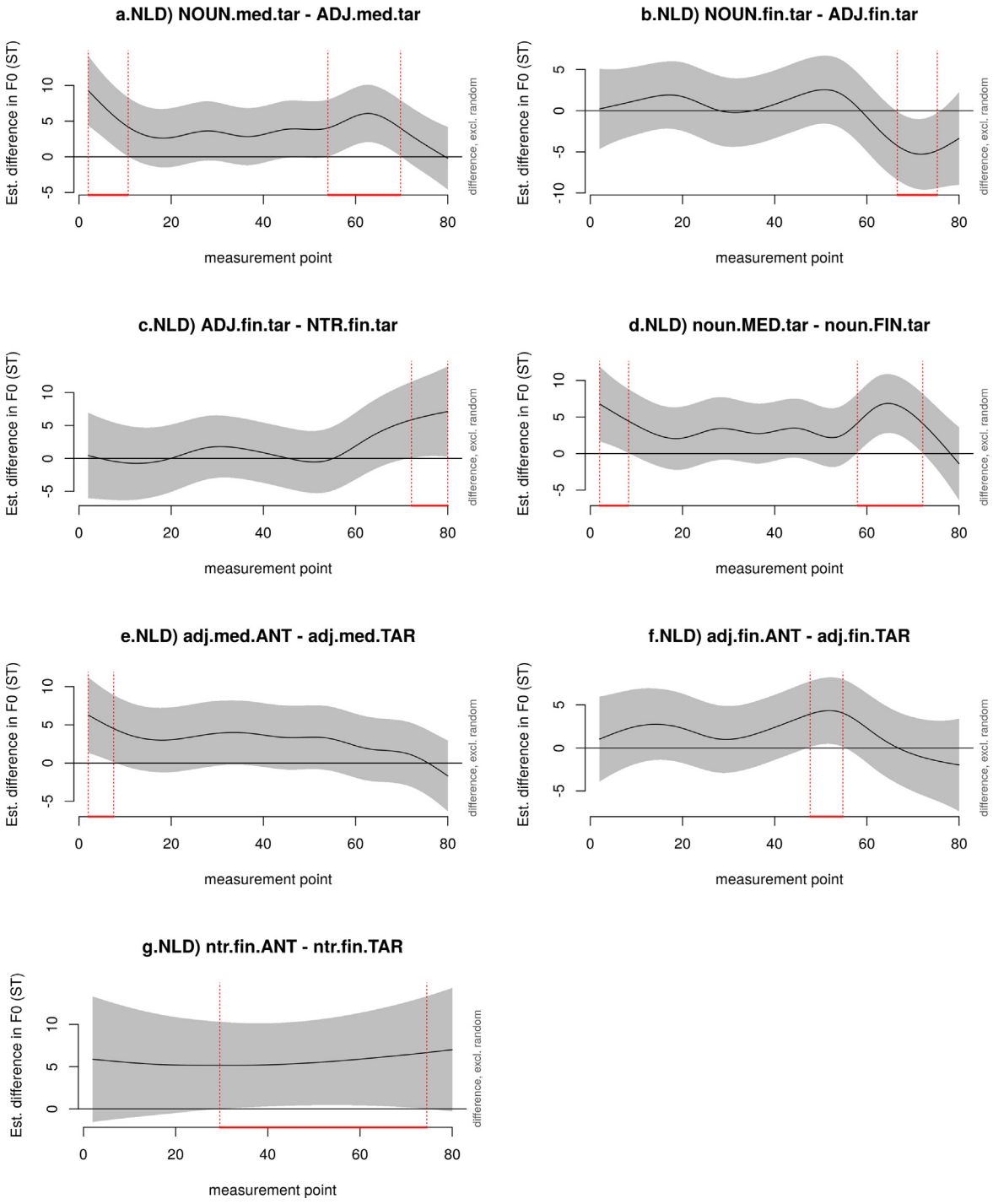


Fig. 8. Difference plots for Dutch showing intervals (red dotted lines) where the compared predictor levels (in capitals) showed significant differences corresponding to Table 5. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

syllables and this is seen as a different process than the realisation of boundary tones at the phrase level. In Papuan Malay, less is known about how f0 movements should be interpreted in the prosodic structure of this language. This point is further discussed in the following, with particular attention given to the other Trade Malay varieties.

The question of whether there is asymmetry between the word level and phrase level of prosody in Papuan Malay has been introduced in Section 1.3.5. The current results indicate that Papuan Malay does not make use of pitch accents to mark contrastive focus. This result resembles the analysis of Ambonese Malay (Maskikit-Essed & Gussenhoven, 2016) in that no prosodic marking of (contrastive) focus was found in any of these languages. There are, however, two potential differences between Papuan Malay on the one hand and Manado Malay and Ambonese Malay on the other hand. That is, in Manado Malay some types of focus could be marked by f0 (Stoel, 2007). Concerning Ambonese Malay, this language was reported to lack pitch accents in general and to only make use of phrase final boundary tones with a loose temporal peak

alignment (i.e. somewhere around the boundary between the pre-final and final syllable). Although the current study indeed shows that pitch accents marking contrastive focus are lacking in Papuan Malay, the results shed a new light on the intonational structure of phrase final f0 movements compared to Ambonese Malay. For the latter language HL% boundary tones were described (Maskikit-Essed & Gussenhoven, 2016), whereas the results of the current study hint at the existence of two variants (speculative ToBI labels): (H) H% and (H) L% in phrase final position (antecedent and target respectively).

The status of the H tone preceding the boundary tone is not immediately clear (hence the above notation between brackets). From Fig. 6a it can be observed that the penultimate syllable in the NP (the first syllable of the adjective in Papuan Malay) shows a rising f0 in all conditions, even the phrase medial ones. Although this penultimate rise might seem an anticipation to the further rising of f0 in the following syllable, phrase final target NPs (Fig. 6a, bottom right) show a rise even before a falling f0 on the phrase-final syllable. The latter observation suggests that there are at least two tonal targets; one in the pre-final syllable (H) and one in the final syllable (H for phrase-final antecedents, L for phrase-final targets). The tonal target in the phrase-final syllable therefore seems to be determined by the degree of finality (as discussed in Section 4.3); continuation is signaled by H targets and finality is signaled by L targets. Thus, boundary (type) marking seems restricted to the final syllable in the phrase.

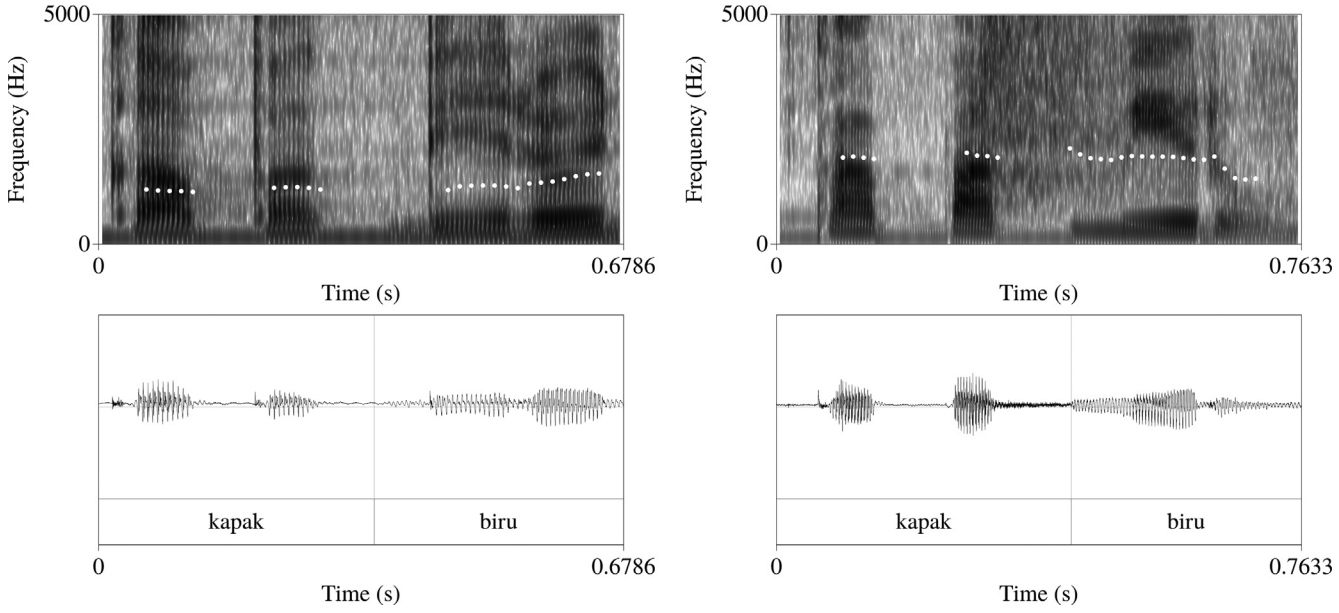


Fig. 9. Papuan Malay example NPs with neutral focus in medial (left) and final (right) phrase position.

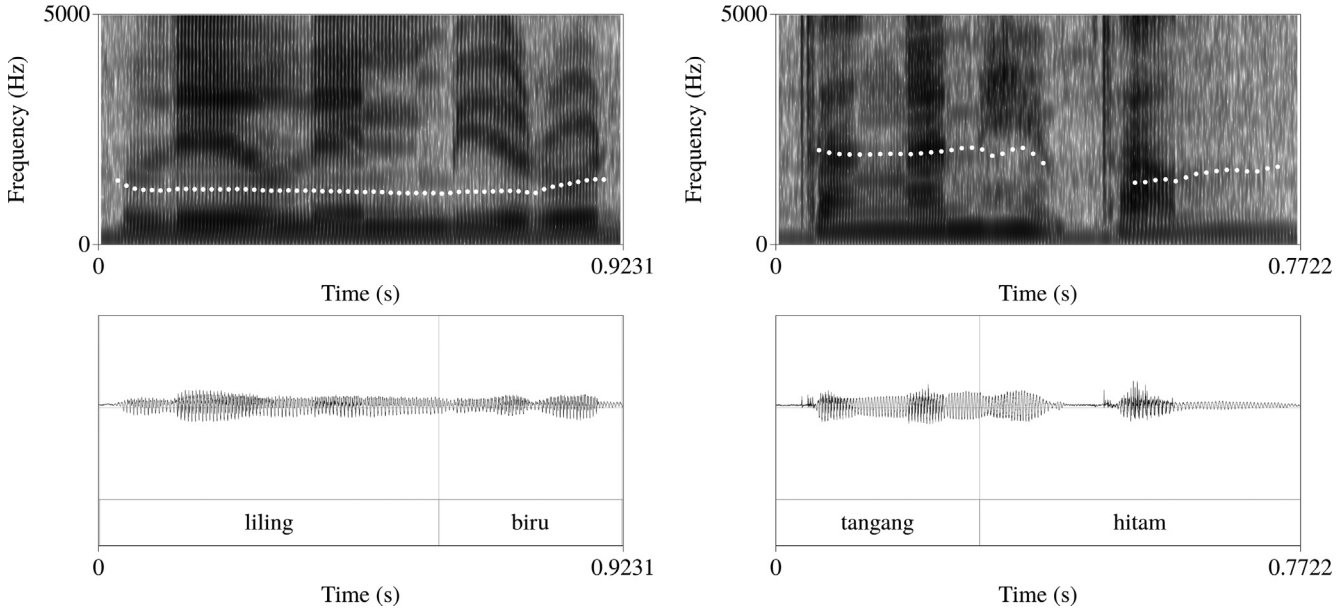


Fig. 10. Papuan Malay example NPs with noun focus in medial (left) and final (right) phrase position.

Whether or not the rise in the penultimate syllable is part of the boundary tone remains therefore unclear. It could be that the penultimate H target originates from a prosodic level other than the phrase. This observation is particularly supported by its constant shape in all experimental conditions, unaffected by focus, phrase position or phrase type. In this respect it is important to note that penultimate syllables predominantly stand out as acoustically prominent at the word level (Kaland, 2019), in accordance with the claim that Papuan Malay has regular penultimate word stress (Kluge, 2017). In the current experimental setup, the adjectives referring to the colors are indeed reported as having penultimate stress (Kluge, 2017). Together, these outcomes seem to suggest a privileged status of the penultimate syllable, also at the phrase level. Thus, these results indicate that at the phrase-level the f0 rise structurally marks the penultimate syllable, which is acoustically promoted mainly by duration and intensity cues at the word level. It is therefore difficult to maintain that the penultimate rise is only part of a phrase level (bitonal) boundary tone as in Ambonese Malay (Maskikit-Essed & Gussenhoven, 2016), not aligned to any word level stress.

In Papuan Malay, words with penultimate and ultimate stress would need to be compared in phrase final position, to determine whether word stress in this language indeed determines rises found at the phrase level. Preliminary evidence suggests that there is some correlation between the location

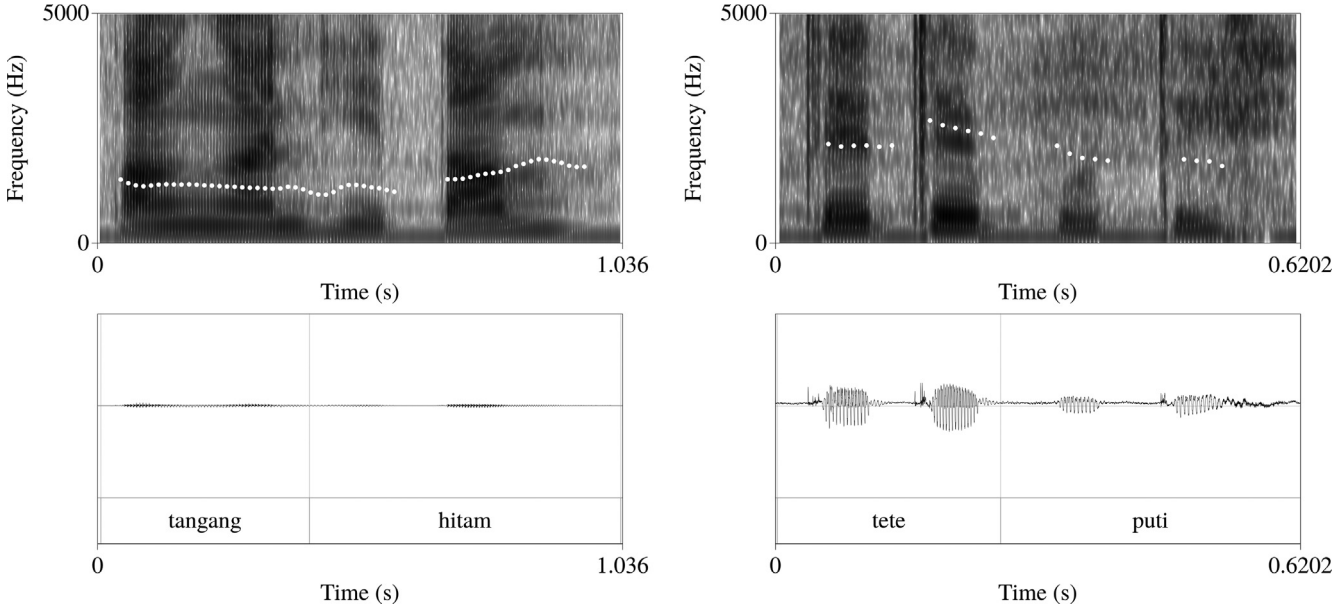


Fig. 11. Papuan Malay example NPs with adjective focus in medial (left) and final (right) phrase position.

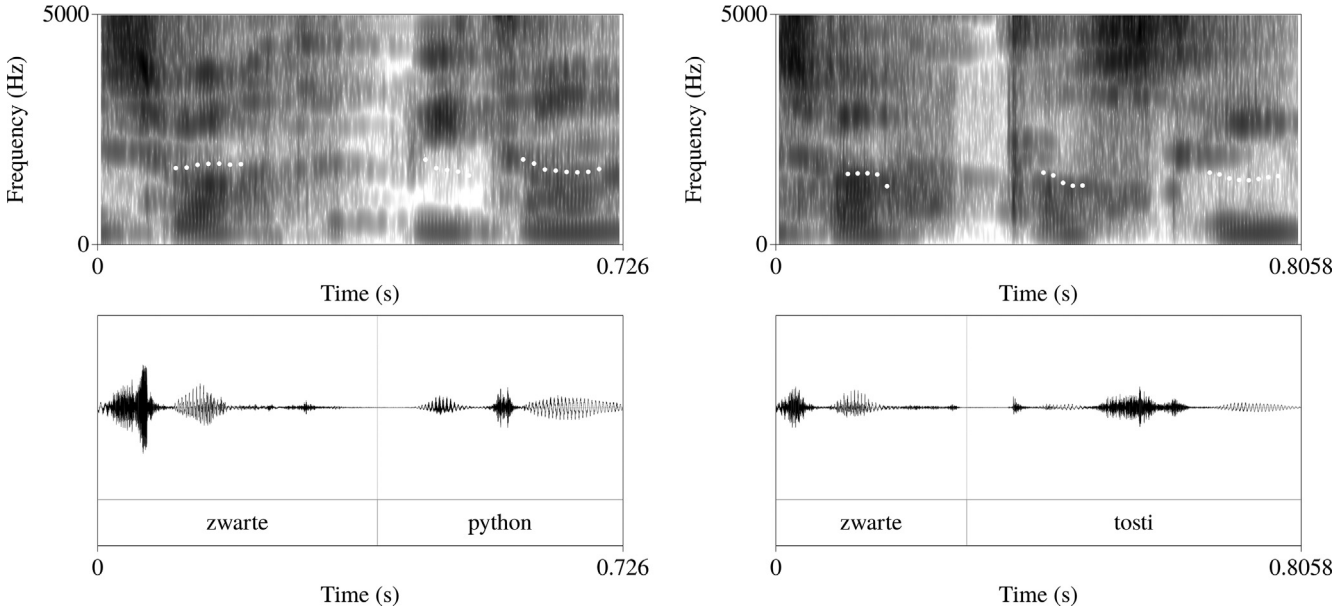


Fig. 12. Dutch example NPs with neutral focus in medial (left) and final (right) phrase position.

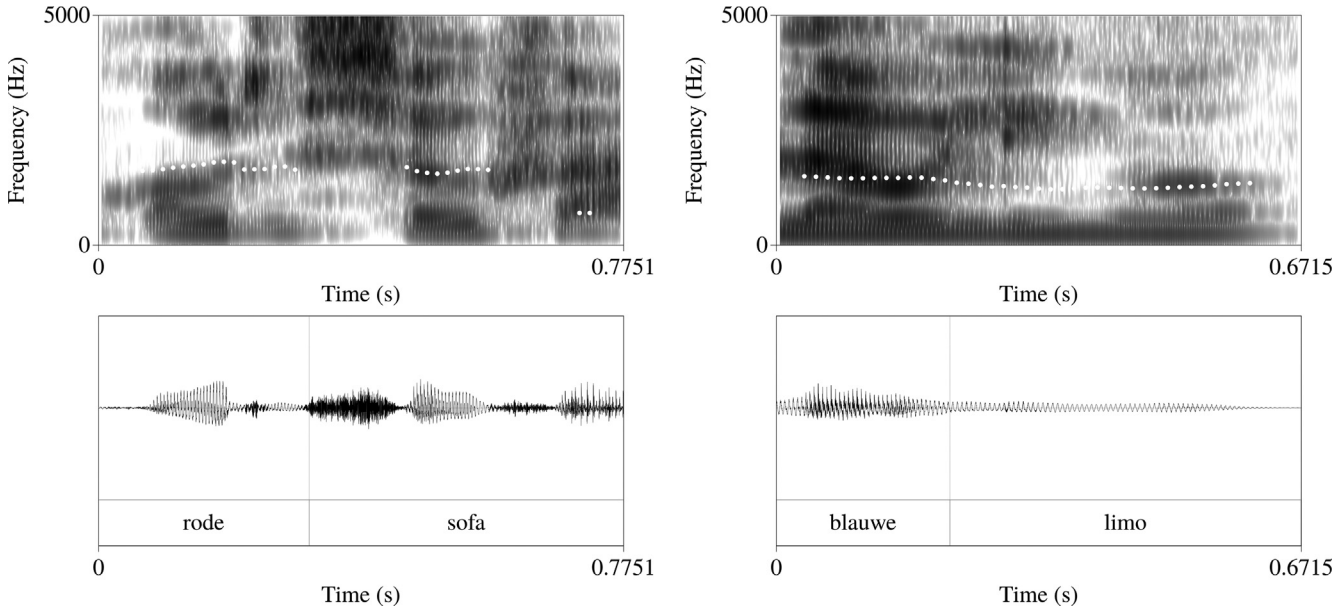


Fig. 13. Dutch example NPs with noun focus in medial (left) and final (right) phrase position.

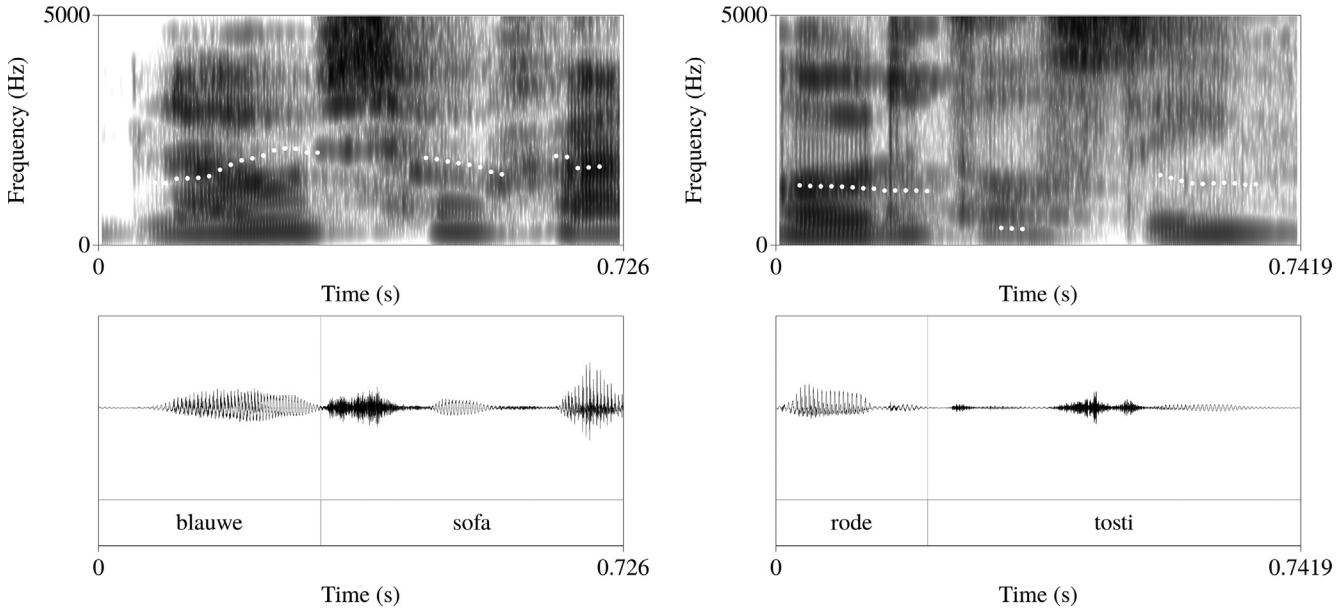


Fig. 14. Dutch example NPs with adjective focus in medial (left) and final (right) phrase position.

of the f0 rise and word stress, however mainly in final phrase positions (Kaland & Baumann, 2020). Ultimate stress is particularly rare in Papuan Malay, which challenges paradigms that aim to investigate the phenomenon empirically (e.g. Kaland, 2020). Thus, the current results do not allow us to conclude whether pre-final rises in Papuan Malay phrases constitute evidence for the alignment of phrase accents to stressed syllables, as reported for Manado Malay, for example (Stoel, 2007). Some form of f0 alignment to syllables that obtained their prominence at the word level cannot be ruled out either. Recall that in Kaland (2019) f0 only weakly correlated with word stress. It is therefore unclear how stable the f0 alignment would be. If the penultimate rise is indeed aligned with stressed syllables, it is plausible that boundary tone placement in Papuan Malay is restricted to final syllables only, i.e. restricted to the final tone in the bitonal movement. This analysis would be different from Ambonese Malay, where word stress is lacking and phrase final boundary tones are loosely aligned (Maskikit-Essed & Gussenhoven, 2016). To this end an alignment study would need to be conducted, possibly showing a more stable anchoring of the rise in Papuan Malay.

Regardless of the question of (autosegmental) alignment and given the likelihood of pre-final syllables in the phrase to coincide with penultimately stressed in the word, it is plausible that the two prosodic levels feed into each other (see Gordon (2014) for an account). How exactly the relationship between these levels should be interpreted remains largely an open question for future studies. From the current study we can con-

clude that stressed syllables at the word level in Papuan Malay do not provide anchors for contrastive focus marking by means of f0, as is the case in Dutch. Papuan Malay appears to be a language that does not mark contrastive focus in NPs by means of f0 at all, revealing fundamental differences in prosodic structure and word order.

CRediT authorship contribution statement

Constantijn Kaland: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization. **Marc Swerts:** Conceptualization, Writing – review & editing. **Nikolaus P. Himmelmann:** Writing – review & editing, Supervision.

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Appendix A

See Figs. 9–14.

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