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Preface

This volume of WPLC follows the 35th annual NorthWest Linguistics Conference (NWLC), which was held in April of 2019 at the University of Victoria. The contributors to this volume were all presenters at NWLC 35, and we are very proud to be able to showcase their work here as conference proceedings.

Emmanuelle Buaillon and Mitchell Xiao Xiao Li

WPLC 30
Victoria, January 2020

A reanalysis of CV- Reduplication in Comox-Sliammon

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Previous descriptions of Comox-Sliammon (ʔayʔaǰuθəm) list three types of CV reduplication: imperfective, plural, and diminutive (Watanabe 2003). Though the proposed reduplicant is a CV prefix across all three types of reduplication, the processes are not homophonous. The root vowel is argued to be retained in imperfective reduplication, but deleted in diminutive and plural reduplication (Watanabe 2003). The prefixing CV- analysis requires positing that input-reduplicant faithfulness is more valued by the grammar than input-base and base-reduplicant correspondence, which is undesirable under Base-Reduplicant Correspondence theory (McCarthy & Prince 1995). In this paper, I argue that the difference between imperfective, plural, and diminutive reduplicative processes arises from two sources: (1) the morphological domain to which they attach, and (2) whether a particular ranking of alignment constraints within a specific domain favours reduplicant or root material at the left edge. Descriptively, the imperfective reduplicant is truly a prefix, while the plural and diminutive reduplicants are realized as infixes. In order to account for the different affixal positions (infix or prefix), a Stratal OT approach is adopted (Kiparsky 2008), whereby infixation is motivated by $\textsc{AlignL}_{Rt}$, which is ranked above $\textsc{AlignL}_{Red}$ at the stem-level and prefixation is preferred by the opposite ranking ($\textsc{AlignL}_{Red} >> \textsc{AlignL}_{Rt}$) at the word-level. Reanalysing "root vowel deleting" CV reduplicants as infixes avoids theoretical issues and is more consistent with the Comox-Sliammon grammar.
Keywords: reduplication; Salish; Comox-Sliammon; diminutive; plural; imperfective; Stratal Optimality Theory, infixes

1 Introduction

Reduplication is found in each of the twenty-three Salish languages with varying degrees of productivity. C_1 reduplication, or the copying of an initial consonant, is a relatively common process across the family can (in form) be traced back to Proto-Salish with relative ease and is generally associated with a "diminutive" function (Kroeber 1999). An additional plural C_1 reduplication also has echoes across the Salish language family, though it is lexicalized in many languages. For example, a variant of C_1a- reduplication is used to mark collective plurals in Lushootseed (Bates, Hess, & Hilbert 1994), but only occurs with a small number of entries in the dictionary. Similarly, van Eijk (1981) documents a handful of C_1

plural forms in Lillooet, though C_1C_2 reduplication is the standard (and more productive) marker of plurality. In contrast to these languages, Watanabe (2003:376-384) documents C_1 plural reduplication in Comox-Sliammon with a wide number of roots.[1]

A third type of C_1 reduplication is found in Central Salish, marking a diversion from the rest of the language family; Kroeber (1999) describes an additional type of C_1 reduplication that serves an aspectual function and is distinct from the historically robust diminutive pattern. Following Watanabe (2003) and other previous work on Comox-Sliammon, I adopt the term "imperfective" here, though there may be a more (or just as) precise semantic label.[2] Comox-Sliammon (ʔayʔaǰuθəm) has a highly productive reduplication system that includes diminutive and plural C_1 reduplication, alongside the imperfective. This paper provides a constraint-based phonological analysis that accounts for all three types of C_1 reduplication.

2 Background

2.1 Basic facts about Comox-Sliammon phonology

Comox-Sliammon (ʔayʔaǰuθəm) is a Central Salish language traditionally spoken by the Tla'amin, K'ómoks, Homalco, and Klahoose communities in British Columbia. In 2018, First Peoples Cultural Council (FPCC) reported approximately 47 L1 speakers. The data used in this paper largely comes from Watanabe (2003), but is supplemented by original fieldwork where relevant.

Comox-Sliammon has distinctive phonological patterns that set it apart from other Salish languages. For example, it has lost all non-root material at the right edge of the word under influence from the neighbouring Wakashan language Kw'akwala (Kinkade 1996). The only remaining prefixes are reduplicative ones, meaning that many of the hallmark Salish prefixes, such as the nominalizer *s-*, are absent (Blake 2000). These facts, combined with a ban on complex onsets clusters and preference for bimoraic feet, limit the size and frequency of consonant clusters in the language (Watanabe 2003).[3] In addition to

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[1] A major restriction on its distribution appears to be aspectual; C_1 reduplication is documented almost exclusively with stative predicates.

[2] The exact function of aspectual reduplication in Central Salish may be language-specific and is better understood in certain languages. For example, Bar-el (2008) conducts a series of semantic tests to support using the term "progressive" for the cognate reduplicative process in Squamish. In other cases (for other languages), the evidence behind an author using a certain label is less transparent and this complicates cross-Salish comparison based on previous description alone. Even the descriptions of Comox-Sliammon give varying labels for the function of C_1 aspectual reduplication, including imperfective (Harris 1981; Kroeber 1988; Watanabe 1994; Blake 2000; Watanabe 2003), progressive (Hagège 1981; Blake 1992), and continuous/repeated action (Harris 1981).

[3] As coda consonants are moraic in the language (see Blake 2000),

this, placement of stress falls on the initial syllable in both reduplicated and non-reduplicated words (Blake 2000).

2.2 Previous analysis of "CV-" reduplication in Comox-Sliammon

Previous descriptions of Comox-Sliammon describe three types of "C_1V-" reduplication: diminutive, imperfective, and plural (Davis 1971; Blake 2000; Watanabe 2003). These are shown in (1) for *k̓əp*- 'to cut', which is a "weak" root because it surfaces with /ə/, and (2) for *ǰuθ*- 'to push', which is a "strong" root because it has a full vowel in its underlying form. Phonemic transcriptions are given in the North American Phonetic Alphabet (NAPA) notation.[4]

(1)	k̓əp	'to cut'	*Diminutive*	**k̓́ə**k̓p̓t	'cut a little'
			Plural	**k̓́ə**k̓pit	'all cut up'
			Imperfective	**k̓́ə**k̓ptas	'she is cutting it'
(2)	ǰuθ-	'to push'	*Diminutive*	**ǰu**yθut	'nudge'
			Plural	**ǰu**yθut	'push over and over'
			Imperfective	**ǰu**ǰuθut	'pushing'

The reduplicants in (1) and (2) are bolded following the "CV-" prefix analysis given in the literature. Accordingly, one must posit that a C_1V reduplicant is prefixed and the root vowel is deleted in plural and diminutive reduplication.

Considering the data alone, there is unexplained homophony between plural and diminutive reduplication, to the exclusion of imperfective reduplication. If all three processes are analysed as instances of "C_1V-" reduplication, it is not evident why identical phonological behaviour would not be observed across all three or, alternatively, why each type of reduplication would not have its own form. The analysis in this paper provides an alternate account of C_1 reduplication. I argue that C_1 reduplication occurs at either a stem or word level and that the homophony between the plural and diminutive reduplicative processes arises from the two occurring earlier in the derivation and surfacing as infixes, rather than prefixes.

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[4] The alternation between /ǰ/ and /y/ in (2) is a regular alternation; voiced "obstruents" only occur in an onset position (see Blake 1992; Blake 2000).

3 Infixing C_1 reduplication

3.1 Parallel between plural and diminutive C_1 reduplication

Plural and diminutive C_1 reduplication are often homophonous in Comox-Sliammon. As an example, each of the forms in (3) is C_1 reduplicated and the form is ambiguous in meaning. In each case, the plural and diminutive C_1 reduplicated forms are homophonous.

(3)	a.	k̓ʷik̓ʷɬit	‘they are spilled’	‘it is spilled a little bit’
	b.	x̣ix̣mus	‘scratched all over the face’	‘a little scratch on the face’

As the plural C_1 and imperfective C_1 reduplicative processes occur frequently on the same roots (verbs), I will provide plural C_1 examples under the assumption that this analysis can be straightforwardly extended to parallel diminutive forms.

3.2 Analysis of plural C_1 reduplication

Plural C_1 reduplication is shown in (4) with strong CVC roots in data from Watanabe (2003). Following the traditional “CV-“ analysis, the reduplicant (bolded) is considered to be a CV prefix and the root vowel is deleted.

(4)	a.	**ʔa**ʔmut	‘they are all home’	ʔamut	‘be home’
	b.	**hu**hǰigis	‘they were all dressed up’	huǰigis	‘she is dressed up’
	c.	**ƛ̓u**ƛ̓x̣ʷit	‘everybody is crying’	ƛ̓ux̣ʷit	he is crying’
	d.	**mi**mq̓šiṅ.	‘have both feet in water’	miq̓šin	‘have foot in water’

The data and assumptions in (4) raise concerns for both theory and the grammar of the language. There are three types of correspondence that are relevant: input-base, input-reduplicant, and base-reduplicant. Faithfulness constraints evaluating input-base correspondence are argued to be universally ranked above base-reduplicant ones (McCarthy & Prince 1995). An input-reduplicant correspondence relationship was only stipulated to account for a small set of patterns that are not otherwise accounted for, such as distributive reduplication in Klamath (McCarthy & Prince 1995). As shown in Table 1, the only type of faithfulness that accounts for the reduplicant vowel under a “CV-” analysis is between input and reduplicant.

Table 1. Types of correspondence in Base-Reduplicant Correspondence Theory

Type		**Correspondence**	**Vowel Faithful?**
↕ Input-Output	Input ↔ Base	ʔamut ↔ ʔmut	No
	Input ↔ Reduplicant	ʔamut ↔ ʔa	Yes
↔ Output-Output	Reduplicant ↔ Base	ʔa ↔ ʔmut	No

While it is possible that Comox-Sliammon may make use of a marked input-reduplicant correspondence relationship, like it has been proposed for Klamath, root vowel deletion is also problematic for the grammar of the language. Epenthesis is often preferred as a repair strategy to avoid hiatus or clusters where non-affixal content is concerned (Blake 2000). Taken together, the deletion of a root vowel in plural and diminutive C_1 reduplication is highly marked cross-linguistically and within the language. Adopting a C_1 infix analysis resolves the Input-Reduplicant >> Base-Reduplicant and Input-Reduplicant >> Input-Base Correspondence issues in the "root vowel deletion" cases, and it also addresses the highly marked deletion of root content. The data in (5) shows this reanalysis, with bolding used to indicate the infixed position of the reduplicant. No root vowel deletion is posited in (5).

(5)	a.	ʔa**ʔ**mut	'they are all home'	ʔamut	'be home'
	b.	hu**h**y̌igis	'they were all dressed up'	huy̌igis	'she is dressed up'
	c.	ƛ̓u**ƛ̓**x̣ʷit	'everybody is crying'	ƛ̓ux̣ʷit	'he is crying'
	d.	mi**m**q̓šiṅ.	'have both feet in water'	miq̓šin	'have foot in water'

I give a constraint-based analysis assuming a combination of alignment, general faithfulness, and markedness constraints (McCarthy & Prince, 1995). The basic faithfulness constraint is MAX, which penalizes deletion.

MAX: All segments in the input have a correspondent in the output. Assign a violation mark for every segment in the input that does not have a correspondent in the output.

I adopt a gradient alignment constraint to motivate infixation, ALIGN-L_{Red}, following Riggle's (2006) approach to Pima. The misalignment of the right edge of reduplicant to the left edge of a word means that this constraint will always be violated when reduplication occurs. This constraint limits reduplicant size, while a constraint MAX-M ensures that reduplication occurs every time a reduplicative morpheme is in the input. The result is that a bare consonant is generally optimal.

ALIGN(Red, R, Wd, L): (ALIGN-L_{Red}) — The right edge of every reduplicant should align with the left edge of a word. Assign a violation mark for every segment between the right edge of a reduplicant and the left edge of the word.

MAX-M(ORPHEME) — All morphemes in the input must have a correspondent in the output (Yu 2017).

In order for infixation to occur, ALIGN-L_{Red} must be ranked below another alignment constraint, ALIGN-L_{Rt}, which penalizes candidates that do not have alignment between the left edge of a word and a root.

ALIGN(Wd, L, Rt, L): (ALIGN-L_{Rt}) — The left edge of every word should align with the left edge of a root. Assign a violation mark for every left edge of word that is not aligned with the left edge of a root.

The tableau in (6) shows the ranking of these constraints, demonstrating that the infixed candidate (6c) is predicted over the prefixed one (6d). The candidates with a vowel in the reduplicant (6a) and (6b) are ruled out under ALIGN-L_{Rt} and ALIGN-L_{Red}, respectively. The candidate (6e) that satisfies the alignment constraints fatally violates MAX-M because there is no reduplicant in the output.

(6)

	RED + ʔamut	MAX	MAX-M	ALIGN-L_{Rt}	ALIGN-L_{Red}
	a. **ʔa**ʔamut			*!	**
	b. ʔa**ʔa**mut				****!
☞	c. ʔa**ʔ**mut				***
	d. **ʔa**ʔmut	*!		*!	**
	e. ʔamut		*!		

The ranking in (7) predicts infixation in plural and diminutive C_1 reduplication.

(7) MAX-M, MAX, AlignL$_{Rt}$ >> AlignL$_{Red}$

4 Prefixing C_1 reduplication

Imperfective C_1 reduplication patterns differently than plural and diminutive C_1 reduplication. As shown for the strong roots in (8) from Watanabe (2003), there is a copy of the full vowel in the (bolded) reduplicant.[5]

(8)	a.	**ʔa**ʔaq̣̓at	'be chasing him'	ʔaq̣̓at	'chase him'
	b.	**gu**guhum	'be barking'	guhum	'bark'
	c.	**θa**θapiš	'be bathing it'	θapiš	'take a bath'
	d.	**ǰi**ǰix̣im	'be falling apart'	ǰix̣im	'fall apart'
	e.	**ya**yałat	'be calling him'	yałat	'call him'

The constraints and ranking introduced in the previous section do not predict the attested candidates. There is a ranking paradox; ALIGNL$_{\text{Rt}}$ must be above ALIGNL$_{\text{Red}}$ to predict the diminutive and the plural C_1 pattern, but ALIGNL$_{\text{Rt}}$ must be below ALIGNL$_{\text{Red}}$ to predict the imperfective C_1 forms. With the constraint ranking established in (7), ALIGNL$_{\text{Rt}}$ >> ALIGNL$_{\text{Red}}$, the predicted imperfective form would have an infix, as in (9), and be parallel to the plural form. However, if the alignment constraints are reversed, as in (10), the attested candidate (10b), with the reduplicant as a prefix, wins.[6]

(9)	RED + ʔaq̣̓at	MAX	MAX-M	ALIGN-L$_{\text{Rt}}$	ALIGN-L$_{\text{Red}}$
☹	a. ʔa**ʔa**q̣̓at				****!
☹	b. **ʔa**ʔaq̣̓at			*!	**
☞	c. ʔa**ʔ**q̣̓at				***
	d. **ʔa**ʔq̣̓at	*!		*!	**
	e. ʔaq̣̓at		*!		

[5] For length restrictions, weak root patterns are set aside. These are as shown in (1) with the root *kə̓p-* 'to cut' and homophony is observed across all three types of reduplication. A complete analysis would also integrate sonority constraints to account for cluster patterns.
[6] Constraints against complex onsets are assumed to be high ranked in the grammar, following Blake (2000). This prevents a candidate with a single consonant reduplicant, like **ʔ**ʔaq̣̓at, from winning.

(10)

RED + ʔaq̓at	MAX	MAX-M	ALIGN-L$_{Red}$	ALIGN-L$_{Rt}$
a. ʔa**ʔa**q̓at			****!	
☞ b. **ʔa**ʔaq̓at			**	*
c. ʔa**ʔ**q̓at			***!	

5 Stem and word level reduplication

Adopting different levels (or strata) in the style of lexical phonology (Mohanan 1982; Kiparsky 1985) offers a solution for the divergent patterns found between types of C_1. Specifically, using Stratal OT instead of a parallel model of OT allows for constraints to be ranked differently at the stem and word level (Kiparsky 2008). This allows for the derivation of different C_1 reduplication patterns.

The infixed pattern is associated with the ranking in (11), while the prefixed one is associated with (12). I propose that diminutive and plural reduplication occur at an earlier point in the derivation than imperfective reduplication. In this respect, diminutive and plural C_1 reduplication are *Level 1* processes and imperfective reduplication is a *Level 2* process, where the numbering corresponds to the sequence of evaluation. The *Level 1* processes correspond to a Salish equivalent of a morphological stem domain, while the *Level 2* processes correspond to a word domain, following previous terminology in Stratal OT (Kiparsky 2008).[7]

(11) MAX-M, MAX, AlignL$_{Root}$ >> AlignL$_{Red}$ *Level 1*

(12) MAX-M, MAX >> AlignL$_{Red}$ >> AlignL$_{Root}$ *Level 2*

There are desirable additional consequences of this analysis as well: imperfectivity is inflectional, while the diminutivity and plurality are ostensibly closer to the root.[8] Though this analysis seeks to account for patterns in

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[7] There has been work on phonological and morphological domains in Salish by Czaykowska-Higgins (1993). It is not clear if these domains line up neatly with the Stratal OT literature, which draws evidence from other languages.

[8] Further evidence for this analysis comes from patterns observed when plural ablaut and C_1 reduplication co-occur. When ablaut is combined with imperfective reduplication in the form *k^{w}ak^{w}atigan* 'they are passing by', the ablauted vowel (/a/) is doubled (singular imperfective form = k^{w}ək^{w}tigan 'it is passing by'). In contrast, the ablauted vowel is not copied in the plural form x^{w}ax^{w}sawus 'dark eyes'. This is predicted if imperfective reduplication is posited to occur at a later stratum than the processes of plural reduplication and ablaut (which is stem-internal), such that a stem that undergoes ablaut

phonology and morphology of C_1 reduplication, further refinement may lead to testable predictions regarding the semantics of imperfective, plural, and diminutive reduplication.

6 Conclusion

Consistent with previous descriptions, imperfective reduplication in Comox-Sliammon can be analysed as a prefix. However, diminutive and plural reduplicative processes are better described as infixal. Thus, the C_1 reduplicative processes in Comox-Sliammon can descriptively be divided by position: prefixing and infixing. These positions are motivated by having two alignment constraints (Align-L_{Red} and Align-L_{Rt}) ranked differently at a stem and word level. Plural and diminutive C_1 reduplicants are aligned as infixes into the root, while imperfective C_1 reduplicants are prefixes and attach at the edge of a word. Differentiating between stem-level diminutive and plural C_1 (infix) and word-level imperfective C_1 (prefix) reduplicative processes provides more descriptive power and generates more testable hypotheses regarding the structure of the language.

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will behave parallel to one with a full vowel at the word level when imperfective reduplication occurs.

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Uniformity constraints in German reportive contexts

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In this paper, I analyze variation in interpretations and surface forms of German embedded clauses under reportive verbs. Variation exists in the position and modality of the finite verb. In order to account for this variation, I argue for a pronominal theory of tense and world variables, following Partee (1989), Kratzer (1998; 2005) and Percus (2000). In addition, I propose a hypothesis of uniformity, which restricts the occurrence of binders and variables on the same head. A pronominal approach to tense combined with the uniformity constraint correctly predicts and explains different interpretations of clausal complements of reportive verbs in German.
Keywords: German; Verb-second; Modality; Tense; Uniformity.

1 Introduction

This paper provides an account of German embedded clauses under reportive verbs, such as *sagen* 'to say', *glauben* 'believe', and *behaupten* 'to claim/assert'. Clausal complements of German reportive verbs show variation in surface form in two ways. The first one is the position of the verb. German is a predicate-final language with V2 effects in root-clauses (den Besten, 1983). In embedded clauses, there can either be a V-final order or V2 order. The V-final order is the canonical order with the finite verb left *in situ*. The V2 order only surfaces when the complementizer is absent. The position of the verb gives two possible surface configurations. The second surface form variation is the verbal mood. Under reportive verbs there exists optionality in the modality of the finite verb, which can either be indicative or subjunctive. The German subjunctive is divided into the present – i.e. Konjunktiv I, and the past subjunctive, Konjunktiv II. Both can be used in reportive contexts (Fabricius-Hansen & Saebo, 2004), although for the purposes of this paper I will address the present subjunctive only. The interaction between word order and modality in German embedded clauses results in interpretation variation, depending on the configuration of the two. This is discussed more elaborately in the next section. In this paper, I will argue for a pronominal analysis of tense and world variables, and constraints on the contents of functional heads. Based on this, the interpretation variation caused by word order and mood optionality can be accounted for.

In the next section, I provide a background on the configurations of German embedded clauses, and present the core data that will be used to further explain the phenomenon at hand. This will then be followed by a critical discussion of the existing literature on this phenomenon, after which I will introduce a new hypothesis that relies on a pronominal theory of tense (Partee, 1989; Kratzer, 1998; 2005; 2009) and possible worlds (Percus, 2000). In the last section, I will address a number of unresolved issues and provide directions for further research.

2 Data and Background

There are four major configurations of German clausal complements. In cases where the complementizer is omitted, V2 triggers verb raising to C^0, and in the presence of the complementizer the verb remains in situ. This gives two main word orders in embedded clauses. There also is variation in verbal mood. Under reportive verbs, the finite verb in the embedded clause can either have indicative or subjunctive mood. The two types of variations yield four different configurations, and we will see that there are three different interpretations. Examples (1a-b), from Giorgi (2009: 1856) show modal variation with the verb in situ, and (2a-b), from Sode and Truckenbrodt (2018: 117), modal variation in verb-second position.

(1) a. Thomas hat gesagt dass Sabine krank sei
Thomas has said that Sabine sick *BE. SUBJ*
'Thomas said that Sabine is sick'

b. Thomas hat gesagt dass Sabine krank ist
Thomas has said that Sabine sick *BE.IND*
'Thomas said that Sabine is sick'

(2) a. Was Saskia glaubt, ist, Maria sei in Saarbrücken
What Saskia believes *BE.IND* *Maria* *BE.SUBJ* *in Saarbrücken*
'What Saskia believes is that Maria is in Saarbrücken'

b. ??Was Saskia glaubt, ist, Maria ist in Saarbrücken
What Saskia believes *BE.IND* *Maria* *BE.IND* *in Saarbrücken*
'What Saskia believes is that Maria is in Saarbrücken'

The word order and modal variation visible in examples (1-2) leads to different interpretations (Giorgi, 2009; Sode & Truckenbrodt, 2018). Those are as follows. For (1a), with a subjunctive present in V-final position, the tense of the embedded proposition is interpreted simultaneously to the main clause. As expected for a subjunctive, the truth of the complement in (1a) only needs to hold for the attitude holder in the main clause. This interpretation is also observed for

(2a), where the subjunctive sits in V2 position. The V-final indicative in (1b) is also modally bound, similar to (1a-2a), despite its being indicative. However, the tense on the indicative gets a Double Access Reading (DAR) (Giorgi, 2009), which entails that the present tense in the embedded clause is interpreted at the time of utterance (cf. Abusch, 1988; Ogihara, 1995). Example (2b) yields another interpretation. With an indicative present in V2 position, the embedded proposition is interpreted as a speaker-assertion, and holds true for the speaker of the utterance, according to Sode and Truckenbrodt (2018). The present tense is again interpreted at utterance time.

The four configurations give three different interpretations. The cases with an embedded subjunctive show no different effects as a result of verb movement. The embedded clauses with an indicative verb, however, do. In the following subsection, I will critically discuss a standing analysis by Sode and Truckenbrodt (2018), after which I will present a new hypothesis in section 3.

3 Recent approaches

3.1 Sode and Truckenbrodt (2018)

Sode and Truckenbrodt (2018, henceforth S&T) propose an analysis specifically for V-to-C phenomena in embedded constructions similar to (2). They argue for a structure in which root clauses, or clauses that show root phenomena, have speaker anchoring in the CP (cf. Rizzi 1997), which makes an entire utterance a speaker assertion. V2 in German is a root clause phenomenon, as it is the standard for non-embedded declaratives. Building on Rizzi's idea of speaker anchoring, S&T argue that all root clauses also receive a semantic label in the CP, where the anchoring takes place. The values are BEL and WANT, which are speaker anchors that introduce a belief (assertion) and desire. WANT is the anchor that results in the imperative, and anchoring by BEL triggers assertive force. Either the speaker of the utterance or the subject of the main clause can be the agent of the assertive force. In order to distinguish between the agent of an assertion, S&T introduce the feature [±origo], of which <x,t,w> are the parameters. The parameter x refers to the speaker of the utterance, t to utterance time, and *w* to world of the utterance. S&T formalize it as follows (S&T 2018: 107).

(3) a. [+origo] on BEL or WANT requires that <x,t,w> is the origo.
  b. [–origo] on BEL or WANT requires that <x,t,w> is different from the origo.

The formalizations in (3) mean the following: for [+origo], the variable bundle <x,t,w> correspond with the coordinates of the speaker of the utterance. For [–origo], the utterance is not 'anchored' to the speaker to the utterance, but to the subject of the matrix verb. Translating this to the cases of V2-embedding in (2), the origo feature in C^0 accounts for the difference. In (2a), the CP of the embedded clause contains a [–origo] feature, which means that the parameters on BEL must not refer to the coordinates of the speaker of utterance, but to the subject of the main clause yielding a reading that the proposition holds true for the subject of the matrix clause. In (2b), the feature is [+origo], yielding a reading where the <x,t,w> variables correspond to the speaker, time, and world of utterance. As a result, the proposition in the embedded clause is treated like any other root clause assertion by the speaker. Generalizing more broadly, S&H divide the origo feature as such that [+origo] requires indicative morphology, whereas this need not be true for the subjunctive.

In short, S&T propose a system with feature anchors in the CP, which then account for the speaker assertion with embedded indicative V2 under reportive verbs, as in (2b). However, a number of issues remain under this proposal, which I will outline in the next subsection.

3.2 We Need to Talk about Tense

Under S&H's approach, the speaker assertion of the embedded proposition, as in (2b), follows from the analysis. However, the proposal they put forward ignores the variation displayed in (1). The DAR interpretations of sentences like (1b), with a verb-final indicative, are not included in S&H's analysis, nor do they follow from their analysis. Consider example (1b), from above.

This sentence is not accounted for by S&T, for the following reasons. They argue that [+origo] is an inherent feature value on indicative. [+origo] corresponds with the coordinates of the speaker of an utterance. At the same time, they describe that 'in [reportive] V-final clauses, the indicative seems to be unrestricted' (p. 115; attested by Giorgi, 2009) where it gets a reading that corresponds with [–origo]. If the feature on finite indicatives by default is [+origo], this reading is expected to be unavailable, because the V-final indicative is expected to get a speaker-assertion interpretation, contrary to fact. Under S&T's analysis, this is not the predicted outcome, and it is left unaccounted for. Furthermore, the fact that the sentence in (1b) receives a DAR interpretation is neither mentioned nor predicted. In other words, the interpretation V-final indicative receives is unpredicted and unexplained. The modal interpretation should not be possible, and it remains unclear how exactly tense is derived. Moreover, it is puzzling how tense is fully interpreted on the indicative, whilst it is modally interpreted as a subjunctive. In order to account for these facts, tense needs to be taken into account as a variable that affects the reading. Additionally, the generalization that the indicative is always valued for [+origo] is too strong, and either needs to be adjusted or replaced by a reasonable alternative. The next section will introduce an alternative theoretical approach to account for examples (1-2).

4 A New Hypothesis

In order to account for the variation described in section 1, I introduce an alternative analysis that builds on a pronominal theory of tense and worlds, following Partee (1989), Kratzer (1998; 2005; 2009), and Percus (2000). Under this approach, tense on the indicative is a free variable with respect to a certain time interval *t*. In other words, it is deictic. Tense on subjunctive verbs, however, is similar to a relative pronoun (cf. von Stechow, 1985; Chierchia, 1989; Heim & Kratzer, 1998). By virtue of being a free variable, tense on the indicative cannot be bound. A relative pronoun, however, must be bound by an antecedent, hereby creating a fundamental difference between the tense features that accompany the subjunctive and indicative. I furthermore assume that reportive verbs, or bridge verbs, select a clausal complement, by virtue of which the world variable *w* of the main clause binds the proposition of the embedded clause, leaving a binder in its CP. This yields a situation in which the embedded clause is interpreted as a proposition holding true for the matrix-clause subject.

More concretely, it is represented as follows. In cases where the modal reading is bound to the attitude holder in the main clause, there is a λ in C^0 that serves as a binder for variables *w* and/or *t*. The variables sit in a lower position, where they can be c-commanded by their binder. For the purposes of this paper, I will assume that world and time variables originate in T^0, and that *w* and *t* are bundled together as <*w*,*t*>.

(4) *V-final subjunctive*

$[_{CP}\ [_{C^0}\ \lambda\langle w,t\rangle\ ]\ [_{TP}\ \ldots\ [_{T^0}\ \langle w,t\rangle]\ ]]$

As argued earlier, tense on subjunctive verbs must be bound by an antecedent. Variable *t* on the subjunctive therefore needs to be bound by λ<w,t> in C^0.

Given that interpretations of the embedded clauses with subjunctives are indifferent for movement, there is reason to assume that the variables can also be bound in C^0 – which is similar to how relative pronouns are bound. This configuration, for V2 subjunctives, is given in (5).

(5) *V2 subjunctive*

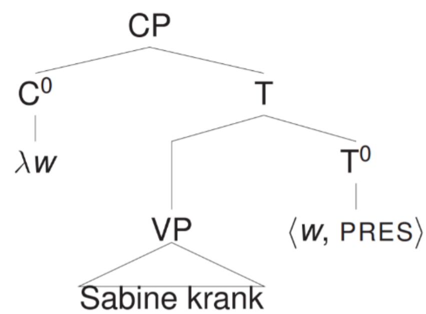
$[_{CP}\ [_{C^0}\ \lambda\langle w,t\rangle\ ]\ [_{TP}\ \ldots\ [_{T^0}\ \langle w,t\rangle]\ ]]$

The configurations in (4) and (5) yield similar interpretations, and the only surface difference is the position of the verb. Example (5) shows that when V2 is triggered, the variables move up with the verb to the position of their binder head, where they are subsequently bound by their λ-abstractor. This procedure falls in line with the treatment of traces and relative pronouns (cf. Heim & Kratzer, 1998).

Overall, the configurations and interpretations of subjunctives follow in an orderly manner from the pronominal analysis of tense. Let us now turn to embedded indicatives and see how the interpretation of the examples in (1) are derived under this approach.

The DAR interpretation of the V-final indicative in (1b) follows from the referential treatment of tense on indicatives. When the embedded proposition contains a subjunctive, the λ-abstractor can be the binder head for both <w,t>. This differs when the finite verb in the embedded clause is indicative. In that case, the tense in T^0 is referential and cannot be bound, i.e. has no binder. The world variable still requires a binder. Under this configuration, there still is a binder head in C^0, binding only world variable *w*. The tense on the indicative is valued. What follows from this, is that the world variable *w* is bound, yielding that the embedded proposition need only hold true for the attitude holder in the matrix clause. Tense, however, is free and interpreted as a present tense variable, giving rise to DAR. Consequently, the tense coordinate is interpreted at utterance time. The syntactic derivation of (1b) is given below in (6).

(6)



The tree in (6) effectively captures what has been described above. Binder λ*w* binds the *w* in T^0. The referential tense is interpreted as is, since it is a free variable.

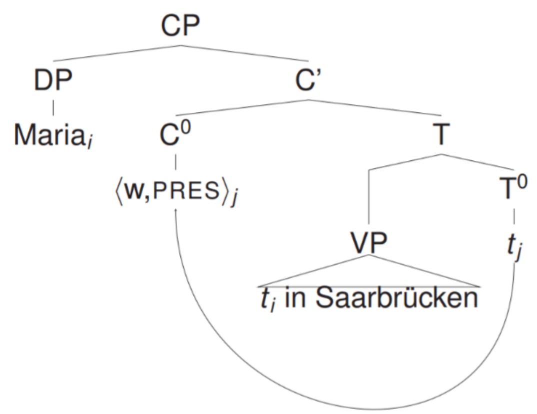
Under the standing analysis we can still not explain how V2 indicative yields a return to speaker assertion. In that case, there is a process similar to (5), in which the variables in T^0 move up to C^0, where the variables are subsequently bound. A return to speaker assertion is not predicted by this process alone. In order to account for the return to speaker assertion in V2 indicative contexts under reportive verbs, I introduce the Uniformity Hypothesis, in (7).

(7) **Uniformity Hypothesis:** A binder and a variable cannot be bundled on the same head.

The Uniformity Hypothesis (UH) entails that one functional head, in this case C^0, can only simultaneously carry variables, but not a binder and a variable. When the indicative verb moves to C^0, the free variable [PRES] moves up together with the world variable, as they are bundled together. As a result, the free tense variable ends up in the same syntactic terminal where *w* binds its trace – in a similar fashion a relative pronoun binds its trace (von Stechow, 1995; Percus, 2000). The consequence is that Uniformity is violated.

To resolve this clash, the world variable *w* is forced to be a free variable, sharing the deictic properties of the tense variable, making sure that the CP-head contains only variables. Movement of the indicative to C^0 therefore yields a speaker assertion of the embedded proposition. The syntactic configuration, following example (2b), is given below in example (8).

(8)



The configuration in (8) exemplifies the speaker assertion of the embedded proposition with V2 indicatives under reportive verbs.

In short, UH straightforwardly predicts that embedded subjunctives under reportive verbs are interpreted similarly, since both the tense and world variable on subjunctives must be bound. The difference between V-final and V2 indicatives also follows from the new hypothesis. The referential head in V-final contexts occupies a lower position than the binder head (as in (6)). In this way, the world variable gets the interpretation that the embedded proposition need only hold true for the attitude holder of the matrix clause. The referential tense gets interpreted as well, extending the time interval beyond the tense reference of the matrix clause. This cannot be the case in V2 indicative environments, where the referential and binder head both occupy the same functional projection. In order to solve the conflict caused by a violation of uniformity, the world variable is forced to be referential, giving rise to speaker assertion.

5 General Discussion

In this section, I will present a number of issues that remain, and which provide directions for further research.

The first issue is that the data presented in S&T (2018) merely provides embedded clauses with forms of *kommen* 'to come' and *sein* 'to be.' The first problem here is that *kommen* shows even less contrast between indicative and subjunctive embedded V2 and V-final constructions (cf. S&T, 2018). That is, there are no interpretational differences between indicative and subjunctive in either V-final or V2 position. Although this might be the case due to independent properties of this verb, this is yet unattested. Since the other data is all set up with *sein* 'to be', the scope of the phenomenon is unclear. It could be that modal shift in V2 only has the said effects for forms of 'to be.' This may or may not be the case but cannot be determined from the data. There seems to be no obvious reason for this. Fabricius-Hansen and Saebo (2004) describe that for more verbs than *sein* 'to be', there is a distinct morphological form for the present subjunctive. It should therefore be tested whether the patterns described in the previous sections hold for more verbs. More data is needed to fully comprehend the scope of the phenomenon argued for in this paper.

The second complication with the data provided so far, is that the sentence type of the examples is inconsistent throughout S&H (2018). The examples presented here are drawn from their work (and Giorgi (2009)), and the pattern is clear in those. However, all other examples are in the form of clefts of pseudo-clefts, as can be seen in examples (2a-b), and S&H seem to claim that the V2 indicative has speaker assertion in only the clefted sentences. This leaves a number of questions. Firstly, using merely pseudo-clefts in the relevant part of the analysis leaves the question open whether the phenomenon is restricted to cleft-like constructions only, or whether there is another purpose served by those examples. This remains unclear and needs to be tested.

Despite the fact that UH comprehensively captures the data discussed above, a closer analysis of the properties of tense is required. Consider example (9), from S&H (2018: 117):

(9)	Was	ich	damals	glaubte,	ist/war,	M. ?ist/*war	in S.
	What	*I*	*then*	*believed*	*is*	*M.* BE.IND.PRES/PAST	*in S.*
	'What I believed at the time is/was that Maria is/was in Saarbrücken						

Given that the subject of the matrix and embedded clause in (9) both have the first person [+ speaker] feature (Harley & Ritter, 2002, among many others), V2 indicative speaker assertion is expected to be felicitous since the subject of the matrix clause is also the speaker of the utterance. However, the temporal adverb and past tense in the matrix clause appear to disallow an embedded V2 past tense, allowing present tense only. S&H (2018) argue that this is because the matrix clause past tense is a shift away from first person speaker assertion, giving rise to a configuration similar to (2b). The interpretation of embedded present indicative in V2 is predicted under Uniformity. The ungrammaticality of embedded past tense under matrix past tense remains puzzling and shows the subtleties caused by tense variation. Further research is needed to get a more robust analysis.

6 Conclusion

This paper has provided a comprehensive overview of modal and present tense variation in German embedded clauses under reportive verbs. The four different surface configurations with three types of interpretations can be accounted for under a pronominal analysis of present tense (cf. Partee, 1989; Kratzer, 2005), and worlds (Percus, 2000). By treating tense on the subjunctive as a relative pronoun that must either bind its trace or be bound, and present tense on indicative verbs as a free variable, most interpretations straightforwardly follow. The Uniformity Hypothesis furthermore requires that one head can host either binders or free variables, but not both simultaneously. In this way, a free tense reading with a modally bound indicative in V2 violates UH. Questions remain, however, about the more precise spell-out of tense relationships.

In conclusion, a pronominal approach of present tense and possible worlds, combined with the Uniformity Hypothesis, comprehensively accounts for the variation outlined in this paper, and makes predictions about the interpretations of the four different surface orders. More research is needed, however, to explain unresolved issues.

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Redefining feature percolation

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The paper describes a possible approach to the phenomenon known as "pied-piping effect", which mends certain inaccuracies of another recent wide-known approach to it — that of Seth Cable (2007). The notion of feature percolation is redefined to mend those inaccuracies, and the consequences of the redefining are then checked on other phenomena.
Keywords: syntax; pied-piping; Minimalism; generative linguistics; features

1 Introduction: Seth Cable's approach

Feature percolation is an operation usually called upon in the context of the so-called "pied-piping effect". The latter term, first introduced in Ross (1967), corresponds to a variety of cases where, instead of a constituent bearing the relevant feature, e.g., a wh-word, another constituent embedding it undergoes A'-movement (simplistically, A'-movement is phrasal movement not related to case and agreement phenomena). That begs for a theoretical explanation given that movement is now believed to be feature-driven, and a multitude of authors, including Cowper (1986), Heck ((2004), inter alia), tried to give one.

Seth Cable wrote many papers on the topic, starting with Cable (2007). According to him, every language has an interrogative particle called Q (in many languages having a phonological zero as its exponent). It bears an interrogativity feature probed by the complementizer head, C (the exact details depend on the Agree theory, see below on the notion of feature), so that QP moves to SpecCP (either overtly or covertly; Spec stands for specifier). This QP either embeds a phrase with wh-feature or adjoins to it, as illustrated by Figure 1 below (which of the two alternative holds depends on the language). Semantically, Q changes the phrase's meaning to a set of contextually relevant alternatives (similarly to particles like *only*). An overt movement of QP embedding the phrase with wh-feature constitutes languages with wh-movement, the other three possible combinations (covert movement and embedding, covert movement and adjunction, overt movement and adjunction) correspond to wh-in-situ languages.

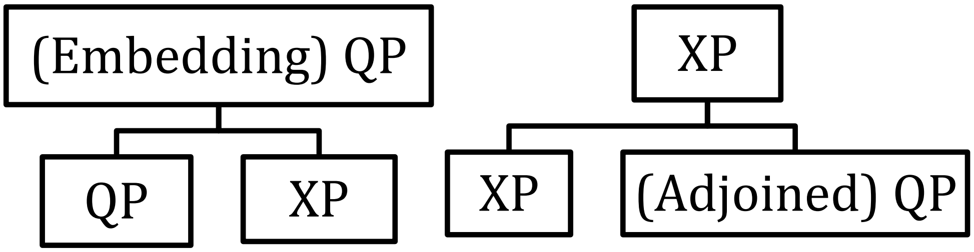

Figure 1. Embedding vs. adjoined QP

By that, the notion of pied-piping is essentially destroyed in Minimalist grammar, remaining only as a descriptive notion: it is QP that undergoes A'-movement, not some undetermined embedding phrase, and the movement proceeds normally. That follows the general logic of locality of Merge.

Cable (2007) claims that percolation beyond a head's maximal projection is also no longer needed and is to be abandoned, according to the Minimalist program (Chomsky, 2000). His argumentation on the issue is taken from Heck (2004) and suggests that percolation is irreducible to Move or Agree: Agree cannot insert features where there were none and Move (a.k.a. Internal Merge) would be expected to obey island constraints (that is, constraints on where a constituent can move from, see Ross (1967) and Chomsky (2000)), which does not hold for most definitions of percolation.

Importantly, Cable (2007) also notes *in passim* that weakening the theory of movement so that any phrase embedding the feature-bearing phrase is empirically inadequate. It is so because different languages show (different) constraints on such movement, like in (1a-b) from English (309 in Cable):

(1) a. Which man do -es Mary believe that Dave like -s?
which man T -PRS.3SG Mary believe that Dave like -PRS.3SG
'Which man does Mary believe that Dave likes?'

b. *That Dave like -s which man do -es Mary believe?
that Dave like -PRS.3SG which man T -PRS.3SG Mary believe
*That Dave likes which man does Mary believe?
'Which man does Mary believe that Dave likes?'

Cable does not require QP to be as close as possible to the wh-feature bearer (unlike Heck), so he has to make some stipulations including the following: no projection of QP can intervene between a functional head and its complement or specifier. That, however, requires him to claim that prepositions in languages allowing for preposition stranding (like English illustrated by (2)) and Larsonian (Larson 1988) light verb v (or, equivalently, Kratzer's (1996) Voice) are lexical heads, as otherwise overt A'-movement of DPs out of PP and SpecvP would both be impossible.

(2)	Who$_1$	did	you	talk	to	t_1?
	Who	T.PST	*you*	*talk*	*to*	
	'Who did you talk to?'					

That, however, leads him to an empirical problem: in the language of Tlingit, which he studies and where the Q-particle is overt, it cannot appear to the right of the verb (and thus VP) which is unexpected if it is a lexical head's complement – for space considerations I refer to Cable's (2007) work for the thorough description of the problem.

2 The redefinition of feature percolation

2.1 Defining feature percolation

It is worth noting that all of Heck's arguments (accepted by Cable) against postulating an independent percolation mechanism only apply to percolation beyond a head's maximal projection. Percolation to maximal projection, however (called feature projection by Heck), appears to be self-evident for them, and any definition of Agree would be vastly overcomplicated without it.

However, the latter operation, which seems obvious to both Cable and Heck, is to be defined formally by itself. Such a definition, if given properly, may allow for percolation of syntactic features beyond the feature-bearing head's maximal projection in certain strictly defined situations – and in all of those pied-piping is obligatory. Let us define it as follows (Zelenskii, 2017):

If β is a daughter node of α, β and α are of the same syntactic category, β has a feature f and α does not have a feature of the same type as f, α receives f from β (=f *percolates* from β to α). In case α has daughter nodes β and γ, both β and γ have a feature of the same type, α lacks a feature of this type and α, β and γ are all of the same syntactic category, but β is not a maximal projection, f percolates to α from β (not γ).

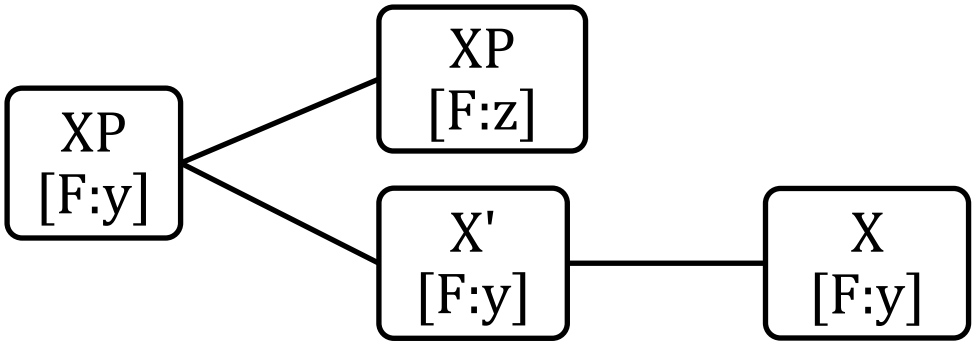

Figure 2. General configuration of feature percolation

Figure 2 illustrates both situations of percolation. Labeling (ascribing syntactic category) under this approach is expected to either be part of Merge or precede all the other feature percolation by a similar (if not the same) rule.

However, the very notion of feature is to be explained, since different Minimalists give rather different explanations of what feature is. My judgments are as follows. For every node and every feature I believe that the node either has an instance of the feature or does not have (a node can metaphorically be said to have a feature, meaning that it has the feature's instance). Every instance of a feature can be either interpretable (and thus go to the Logical Form, LF) or uninterpretable (and thus go to the Phonological Form, PF). Every feature (not an instance, see Feature Sharing in Pesetsky & Torrego (2007)) can also be either valued or unvalued. Unvalued features are to become valued (interpretable instances – before entering LF, uninterpretable can receive it in PF not only in syntax), for which different versions of Agree (such as Chomsky (2000), Zeijlstra (2012), Preminger (2014) or Wurmbrand (2014)) serve. Many theoretical problems of features are observed in Adger & Svenonius (2011). Moreover, every feature has a type, corresponding to the feature's "meaning"; only features of the same type can undergo Agree.

Since at least one object of Merge is a maximal projection and since Merge only generates binary trees, the latter sentence of the definition never fails (so that we will never have two daughter nodes competing for percolation neither of which is a maximal projection). The unresolvable situation, which by this definition is the situation of merging two maximal projections of the same syntactic category (so that the definition cannot choose whose features to percolate), appears to be unattested. For example, under adjunction, noun phrases and adjective phrases are to be embedded in vP (or, in some notations, PredP), creating a so-called small clause with an anaphor PRO as its own "subject". Such adjuncts are adjoined to lexical head phrases but never to vP's as control possibilities in example (3) from Russian (courtesy to John Bailyn) show: subject and direct object can control PRO whereas indirect object cannot.

(3)

Abramovich$_1$	[$_{vP}$ t$_1$	v+prodal$_4$	[$_{VP}$	Arshavin	-a	t$_4$
Abramovich		*sold*		*Arshavin*	-*ACC*	
Rabinovich$_3$	-u	[$_{vP}$ PRO$_{1/2/*3}$	golym]]]			
Rabinovich	-*DAT*		*naked*			

‘Abramovich$_1$ sold Arshavin$_2$ to Rabinovich$_3$ naked$_{1/2/*3}$’

2.2 Consequences for Saxon genitive and external arguments

At first glance it would seem that the definition above prevents any percolation beyond the maximal projection. However, that is not fully correct for situations where a phrase of some syntactic category is a complement or a specifier of the head of the same syntactic category, and this is intentional. If the head has a feature of the relevant type, it will percolate to its maximal projection – so the phrase *devil’s brothers* in (4a) shall be plural (not singular as *devil*) and, vice versa, *devils’ brother* in (4b) shall be singular (not plural as *devils*).

(4) a.

devil	-’s	brother	-s	come	(*-s)	for	me
devil	-*GEN*	*brother*	-*PL*	*come*	-*PRS.3SG*	*for*	*I.OBL*

‘devil’s brothers come for me’

b.

devil	-s’	brother	come	*(-s)	for	me
devil	-*PL.GEN*	*brother*	*come*	-*PRS.3SG*	*for*	*I.OBL*

‘devils’ brother comes for me’

However, the determiner “-’s” lacks wh-feature altogether (not just its value as this could lead to derivation crash in non-interrogative determiner phrases). Therefore, wh-feature is allowed to percolate from specifier so that both *whose father* and *whose father’s books* become interrogative determiner phrases in (5a) leading to obligatory pied-piping. Note that the number feature in (5b) still percolates from the head and not the specifier, as in (4), as figure 3 shows.

(5) a.

whose	father	-’s	book	-s	are	there?
who.GEN	*father*	-*GEN*	*book*	-*PL*	*be.PRS.PL*	*there*

‘whose father’s books are there?’

b.

*whose	father	-’s	book	-s	is	there?
who.GEN	*father*	-*GEN*	*book*	-*PL*	*be.PRS.3SG*	*there*

*whose father’s books is there

‘whose father’s books are there?’

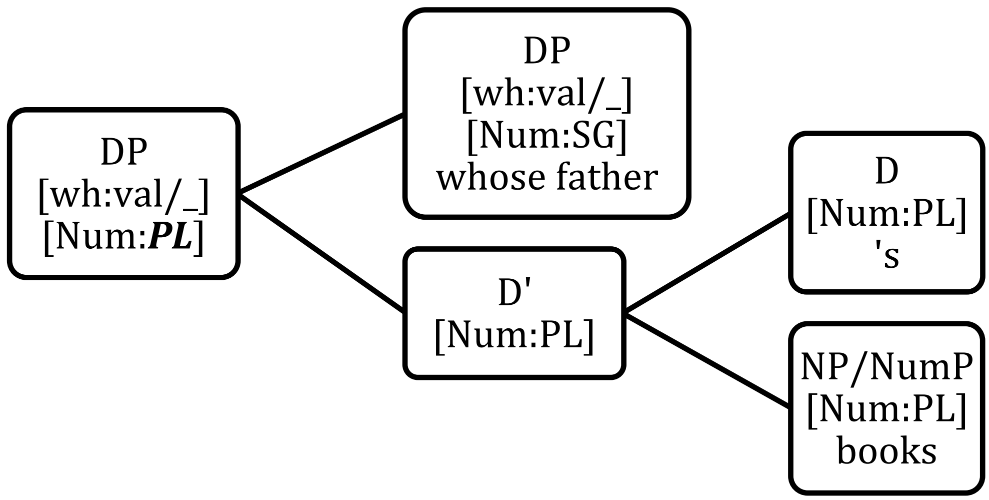

Figure 3. Tree for subject DP in (5a-b) illustrating percolations

Thus a possibility for unlimited embedding of possessors with obligatory pied-piping is created. We can now dispense with Cable's stipulation that disallows QP nodes to intervene between a functional head and its specifier. Instead, we replace it with another stipulation, namely the one that says that QP cannot intervene in structures, which would otherwise be available for percolation. Another stipulation of Cable's, namely, that QP nodes are disallowed to intervene between a functional head and its complement, also still stands.

Now subject as external argument (as per Larson (1988) or Kratzer (1996)) is saved. Since only Q's and D's bear wh-feature, no uncontrollable percolation happens, and thus obligatoriness of pied-piping is limited. Note that Cable allows for fairly distant position of Q if the stipulations are not broken, so that optional pied-piping can still happen beyond such contexts.

So, in essence, refining an independently needed mechanism allowed us to tweak Cable's proposal a bit and get to a both compatible with others' results and more economical model of pied-piping and its syntax.

2.3 Consequences for other structures

Other structures where a phrase of some syntactic category is a complement or a specifier of another phrase of the same syntactic category are now to be discussed. Note that such structures are extremely rare. For example, the famous "that-trace effect", discussed by Pesetsky & Torrego (2001), prevents a TP from being a TP's specifier, as (6) (from English) illustrates:

(6) a.

Everyone	know	-s	(that)	she	came
everyone	*know*	*-PRS.3SG*	*that*	*she*	*come.PST*

‘Everyone knows that she came’

b.

*[$_{TP}$ she	came]	is	know	-n
she	*come.PST*	*be.PRS.3SG*	*know*	*-PTCP*

*She came is known.
‘That she came is known’

c.

[$_{CP}$That	she	came]	is	know	-n
that	*she*	*come.PST*	*be.PRS.3SG*	*know*	*-PTCP*

‘That she came is known’

Aside from the Saxon genitive structure (DP in SpecDP) discussed above, only two structures of the kind (ignoring cartographic syntax) were found: CP in SpecCP in V2 Germanic languages and vP as a complement of v in distant causatives. One may wonder whether phasehood (if phase-causing heads are a closed list as in Chomsky (2000)) is a necessary condition for being able to be a specifier of one’s own category (and, if that’s true, whether we observe PP-in-SpecPP structures). Let us discuss both aforementioned structures in the given order.

In many Germanic languages, German included, there is the so-called V2 rule – head-movement of the finite verb form to the complementizer (T-to-C) combined with A’-movement of a phrase not embedding the moved head to SpecCP. In particular, a dependent finite clause, itself a CP, can move to SpecCP.

Let us consider the German example (7) from Zielinski (1981, p. 30):

(7) a.

Es	interessier	-t	mich	sehr	wie	er	das
it	*interest*	*-3SG*	*I.ACC*	*very*	*how*	*he*	*that*
ge-	mach	-t	ha	-t			
PERF-	*do*	*-PTCP*	*have*	*-3SG*			

‘I am very interested in the way he did it’

b.

Wie	er	das	ge-	mach	-t	ha	-t
how	*he*	*that*	*PERF-*	*do*	*-PTCP*	*have*	*-3SG*
interessier		-t	mich	sehr			
interest		*-3SG*	*I.ACC*	*very*			

‘I am very interested in the way he did it’

Given the information about V2 in German it is obvious that in (7b) the dependent clause *wie er das gemacht hat* is in SpecCP. It is an interrogative clause by itself, but the sentence overall is affirmative. Therefore, percolation, being a value-preserving operation on features, could not have taken place, so we are led to believe that C of the main affirmative clauses has a valued (and interpretable) feature of non-interrogativity belonging to the same type as the interrogativity feature. Were it unvalued, either the derivation would crash or Agree would take place with downward valuation (as per Wurmbrand (2014)) leading to interrogativity.

The last structure where one could expect percolation beyond maximal projection is distant causatives where vP is a complement of v. However, there are two problems with that.

Firstly, many of the languages featuring the relevant type of distant causatives are left-branching, so that head-movement might leave no trace on surface as the verbal heads are stacked at the right edge of the sentence. So, the Buryat example (8) below potentially can feature any of the following movements and their combinations: V-to-v, v-to-v, v-to-T.

(8)	Dugar	Badma	-da	ʉ:dɘ	nʲɘ:	-v	-lgɘ	-bɘ
	Dugar	*Badma*	-*DAT*	*door.ACC*	*open*	-*CAUS*	-*CAUS*	-*PST*
	‘Dugar made Badma open the door’							

Since head-movement values and percolates features it obviously masks “original” feature percolation had it taken place.

Secondly, since v is a functional head and since no projection of Q-particle can intervene between a functional head and its complement, no QP can be inserted between the two vPs, therefore, an obligatory pied-piping is in order anyway.

So, although the distant causative structure could be of interest in principle, it appears to be empirically untestable for feature percolation.

3 Conclusion

This article suggests a more precise description of pied-piping than Cable’s which is at the same time more economical as required by Chomsky’s (1993) Minimalist program and despite introducing a third operation in addition to Merge and Agree of Chomsky (2000). It also combines previously incompatible approaches of Larson (1988) and Cable (2007), each of which has advantages against their alternatives.

For that, a definition of feature percolation, which automatically percolates features to the maximal projections of the feature-bearing heads and does so beyond the maximal projections if and only if it is really needed, was given.

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Foot recursion in interlanguage grammars: A study on expletive infixing

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Recursion is a fundamental property of generative grammars (Watamull, Hauser, Roberts, & Hornstein, 2014). While there is considerable research on interlanguage grammars (White, 2003; Schwartz & Sprouse, 1996), there has been little research into recursion in interlanguage grammars. To further our knowledge in this area, we aim to answer the question of whether second language learners of English have phonological recursion in their interlanguage grammars. Our focus will be on recursion at the metrical foot level.Using a lexical decision task we conducted a forced-choice selection task. The participants judged the grammaticality of swear words that had been infixed into two different spots in the same word (e.g., fan-fucking-tastic vs. *fantas-fucking-tic), where the first form is well-formed according to the infixing principles of McCarthy (1982) but the second item is ill-formed.We analyzed accuracy data to see (a) whether learners can distinguish well-formed from ill-formed strings, and (b) whether the L1 makes a difference. If participants discriminate between well- and ill-formed strings, it will show that they have recursion in their interlanguage grammar.
Keywords: recursion; interlanguage grammar; foot; phonology; lexical decision task

1 Introduction

Recursion is a fundamental property of generative grammars (Watamull, Hauser, Roberts, & Hornstein, 2014). To further our knowledge in this area, we aim to answer the question of whether second language learners of English have phonological recursion in their interlanguage grammars. Our focus will be on recursion at the metrical foot level.

We conducted a lexical decision task with four L2 speakers of English who all had varying L1s. The L1s studied either had metrical feet, or they did not. The participants then chose between two versions of a word with the only word used as an infix in English, *fucking*, inserted at different locations. For example: fan-fucking-tastic vs. *fantas-fucking-tic. The accuracy of the answers were then analyzed.

Clahsen and Felser (2017) claim that interlanguage grammars have shallow (i.e., limited hierarchical) structure only, this suggets that interlanguage grammars are incapable of representing recursive structures. In this paper, we will be disputing these claims.

2 Literature Review

In this section we will explain the key background information necessary to understand the experiment, including a discussion of the evolution of recursion in human language, the operation Merge, as well as the main properties of recursion. Finally, this section will conclude with an outline of the rest of the paper.

2.1 Evolution

There is a rich literature, which looks at the evolution of language in *homo sapiens* (Berwick, Friederici, Chomsky and Bolhuis, 2013; Berwick and Chomsky, 2016). It is clear that animals have the ability to communicate. Non-human primates have call systems, which are somewhat analogous to words in that different calls have different meanings (e.g. *eagle* versus *leopard*). Species such as whales, or birds have songs, which can have internal structure (e.g., sequences of notes). However, the component parts of these songs (i.e., the notes) do not have individual meanings, so the songs are unlike human sentences. What none of human's common ancestors seem to possess is the generative capacity to produce novel utterances in which constituents are structured recursively from simple representational elements. It is truly a central property of human I-language, and thus, interesting to look at whether we find it in interlanguage grammars.

2.2 Merge

Yang, Crain, Berwick, Chomsky and Bolhuis (2017) discuss the recursive process that is responsible for the formation of linguistic structures. This recursive operation (known as *Merge*) combines two linguistic terms to produce a new, composite term. The new term can then also be merged with another linguistic term, and so on until the phrase is fully derived.

Merge is currently thought to be "the fundamental operation of structure building in human language" (Yang et al., 2017, p. 3). We could then extend this theory and claim that the reason humans developed a language, and other animals didn't, is because we are the only ones that developed Merge (Yang, Crain, Berwick, Chomsky & Bolhuis, 2017).

2.3 Recursion

According to Watumull, Hauser, Roberts and Hornstein (2014) there are three main properties of recursion: computability, induction and boundedness. In this section we will briefly discuss these properties. These are properties which underlie our ability to generate sentences such as *The man in the shirt with stripes wondered whether his outfit was appropriate for the wedding in the cathedral.*

2.3.1 Computability

A finite program of rules, states and symbols, and a mechanism for decoding, encoding and manipulating symbols are all necessary for computation. Using the Turing machine as a good example of computation, Watumull et al. (2014, pg. 1) noted that "the machine generates theorems given inputs by returning intermediate results according to its programmed rules." Thus, the grammar is generative; an infinite set of grammatical sentences can be built via such machinery.

This grammar (what Chomsky calls I-language) is, thus, internalized in the human mind/brain, while E-language (or *external* language – the sentences people actually produce) is generated and constrained by I-language.

They conclude by stating that- "computable functions are therefore those calculable by finite means." The infinite capacity of human language can be modeled computationally.

2.3.2 Induction

Watumull et al. also discuss a key property (first noted by Gödel) of recursive functions: induction.

This property of a generative grammar was originally shown in Post's rewrite rules (Watumull et al., 2014). These rules were in the following form:

$$\boldsymbol{\varphi \rightarrow \psi} \textbf{ ("rewrite } \boldsymbol{\varphi} \textbf{ as } \boldsymbol{\psi}\textbf{")}$$

This type of rule derives hierarchical syntactic structure. So, a verb phrase could be re-written as V + NP. Watumull et al. wrap this up by stating, "a grammar strongly generates hierarchically structured expressions [the I-language] and weakly generates the corresponding strings [the E-language]" (Watumull et al., 2014, p.3). The structure is what conveys grammatical information. The information can then be mapped, via linguistic processing, to the conceptual-intentional (LF) and the sensory-motor (PF) systems.

2.3.3 (Un)boundedness

The final property to discuss is (un)boundedness, which has two important aspects. First, a recursive function may generate an infinite set of possibilities, but only produce a finite output, because of mechanistic constraints. For example, I-language produces E-language. I-language is internalized and it would therefore license every grammatical sentence a human could produce; however, E-language is external, and only illustrates what each human actually says. Not every grammatical sentence gets uttered. No one actually has the time to produce a sentence with 1,000,000,000 words in it.

Secondly, any arbitrarily limited output can be expanded, because recursive functions have no limit (e.g., *The team won the trophy.*; *The coach said that the team won the trophy*,etc.). There is no longest grammatical sentence. Let us turn now to other aspects of this property, such as phonological structure.

2.4 Feet

In most languages, syllables get parsed into metrical feet, which then get parsed into the prosodic word node. Trochaic feet are strong (or prominent) on the left and iambic feet are strong on the right. Three out of the four languages included in this study have foot structure. English, German and Mandarin all have trochaic feet (Weber, 2013; Qu, 2013), whereas French has no foot structure (Özçelik, 2016). In the sections below, we will discuss the structure of German, Mandarin and French with relation to their respective type of foot structure, or the lack thereof.

2.4.1 German foot structure

Figure 1. below shows the foot structure present in German (Weber, 2013). As shown below, the strong syllable (i.e., the more prominent) is on the left of the foot, and the strong foot is on the left of the Word, making the German prosodic structure a trochaic system. In *Figure 1* the symbol ω indicates the prosodic word level, the symbol Σ represents the foot level and the σ indicates the syllable level. The subscript s and w represent strong and weak feet or syllables.

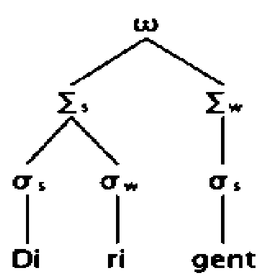

Figure 1. German example of violations of metrical foot structure for the noun *Dirigent* "conductor"

2.4.2 Mandarin foot structure

Below, in Figure 2., is a diagram showing Mandarin foot structure (Qu, 2013). Mandarin feet are also strong on the left (marked with an s on the stronger syllable), making them trochaic as well. In this example PWd is used as a short form for the prosodic word node, the subscript numbers in the Mandarin sentence represent the tones used on each word.

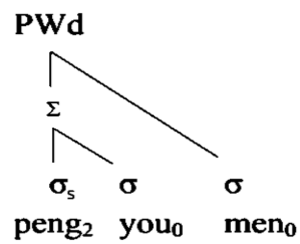

Figure 2. Mandarin foot structure of the phrase *peng₂ you₀ men₀* “friends”

2.4.3 French foot structure

As can be seen in the diagram below, French does not have any foot structure (the syllables are grouped directly into the prosodic word) at all, making it a footless language (Özçelik, 2016). In Figure 3. PPh is used to mark the prosodic phrase node.

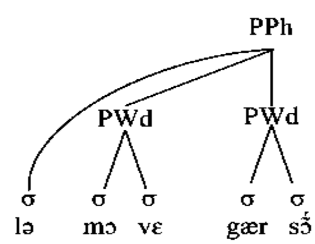

Figure 3. No foot structure is necessary in French for the phrase *le mauvais garçon* “the bad boy”

2.4.4 Foot Structure and Recursion

The tree structures below in Figure 4. show why foot recursion is necessary in English when ‘fucking’ has been infixed into a word. As can be seen in the diagram below, c. is the only well-formed tree structure in that (a) and (b) show the (illicit) crossing of association lines. This is evidence that foot recursion is necessary (McCarthy, 1982) in order to generate these infixed forms. Note that there is a Foot within a Foot in (c) which is clearly a recursive structure.

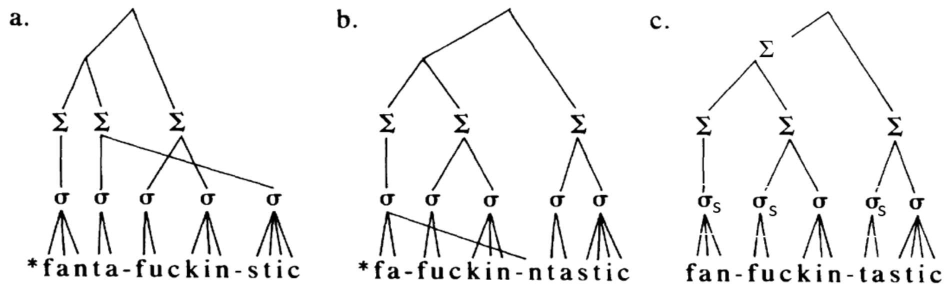

Figure 4. Foot recursion is necessary for infixed forms

2.5 Research Question

This paper aims to answer the question: Do L2 speakers of English have phonological recursion in their interlanguage grammars? Or, as Clahsen & Felser (2017) suggest, are their interlanguage grammars *shallow (*i.e., lacking hierarchical structure)? Using a lexical decision task, L2 learners of English will judge the grammaticality of swear words with infixes in various positions in English words. If participants are accurately able to judge the infixation, it will show that they have recursion (i.e., feet within feet) in their interlanguage grammar. However, if the participants are unable to accurately judge the grammaticality of the infixation, it will show that they do not have recursion in their interlanguage grammar.

3 Methodology

3.1 Participants

There were 5 participants in this study, one 22-year-old native English speaker (as a control), and four-second language speakers. Within the second language speakers there was one female French speaker, one female Mandarin speaker and two German speakers (one male and one female). The second language speakers had been speaking English for a range of 10 to 42 years. They were all of advanced proficiency (all graduate students or professors).

3.2 Materials

The materials used in this experiment were: a background information questionnaire, and a grammaticality judgment task, which was created and run through PsychoPy. The stimuli consisted of 22 pairs of three or four syllable words with the f-word infixed into them, this word list is seen in Appendix A. The pairs consisted of the same word where 'fucking' had been infixed into the correct location for one, and an incorrect location for the other. During the task, the incorrect option was listed first 11 times, and the correct option was listed first the other 11 times. It was decided randomly, which one would come first. A computer and a pair of headphones were also necessary materials for this experiment.

3.3 Procedure

This experiment consisted of two main steps. After signing the HREB approved consent form, participants completed a questionnaire of background information. They then completed the grammaticality judgment task which consisted of the participants listening to and reading the pairs of words, where 'fucking' was either infixed in the grammatical location or the ungrammatical location, and pressing a button on a keyboard that corresponded to their choice.

3.4 Data analysis

Psychopy recorded accuracy and reaction time in an excel spreadsheet. The accuracy of their responses was then analyzed. Reaction time was not analyzed as there were too few participants to allow for statistical analyses.

4 Results

Below are the graphs of the results obtained. Each of the graphs reports on data from a different L1.

The first graph, in Figure 5., is that of the native English speaker control, who had been living in Canada for her entire life (22 years). This participant judged 21 of the 22 pairs of words correctly. The chi squared results for the English speaker were as follows: 1 wrong, 21 correct, p 0.01* $\chi^2(21)$. This validates the experimental task and provides the baseline for our non-native speaker comparison.

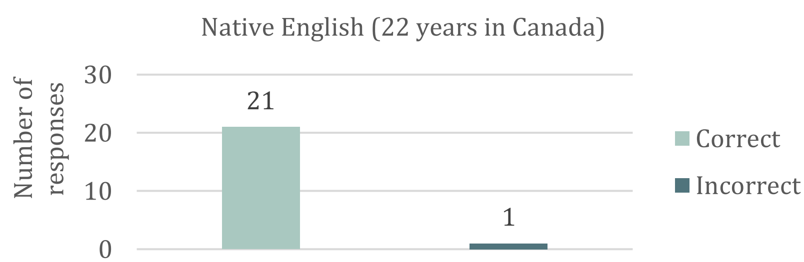

Figure 5. Number of correct and incorrect responses of the L1 English participant

Figure 6. shows the graph representing the responses of the two L1 German speakers. The German L1 participants had been living in Canada for 8 months and 34 years respectively. They both scored correctly on 20 of the 22 pairs of words. The chi squared results for the two German speakers were: 2 wrong, 20 correct, p 0.01* $\chi^2(21)$.

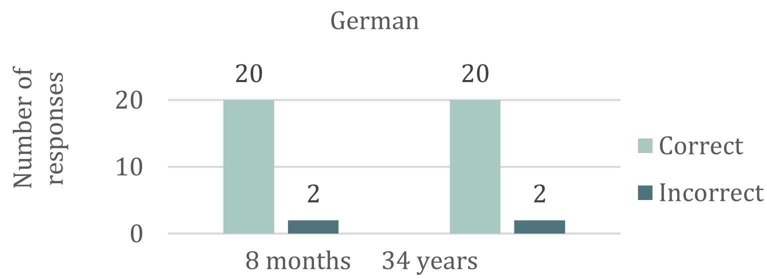

Figure 6. Number of correct and incorrect responses for both L1 German participants

Figure 7. shows the responses of the L1 Mandarin speaker, who had been living in Canada for 3 years. The Mandarin L1 participant got 19 of the pairs of words correct, and 3 incorrect. The chi squared results for the Mandarin speaker was: 3 wrong, 19 correct, p 0.01* $\chi^2(21)$.

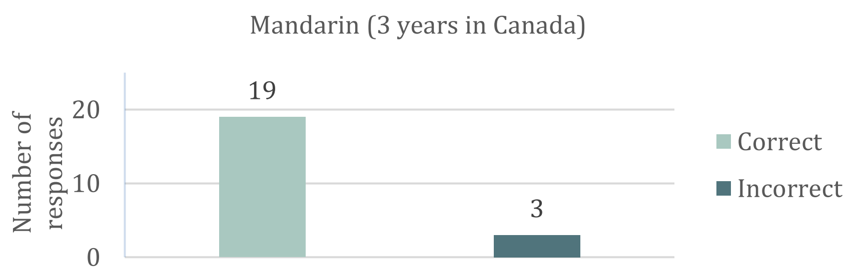

Figure 7. Number of correct and incorrect responses for the L1 Mandarin Speaker

Figure 8. represents the number of correct and incorrect responses for the L1 French speaker who had been living in Canada for 1.5 years. The L1 French speaker scored 18 pairs correctly and 4 pairs incorrectly. The chi squared results for the French speaker was: 4 wrong, 18 correct, p 0.01* $\chi^2(21)$.

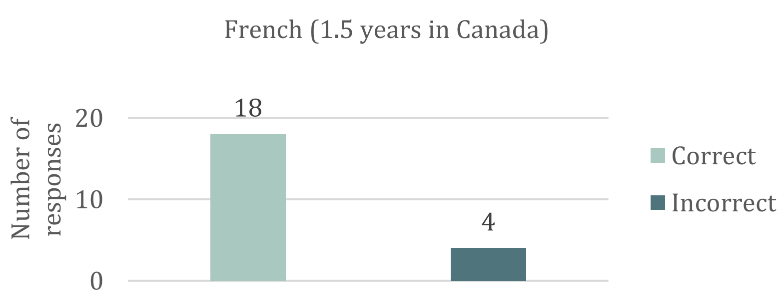

Figure 8. Number of correct and incorrect responses for the L1 French speaker

5 Discussion

The chi-squared test results show that the participants were not guessing when they completed the well-formedness judgment task; the accuracy was well above 50%. We can conclude, therefore, that they are able to accurately judge the grammaticality of expletive infixing, and that this accuracy results from a representation of recursion.

While acknowledging that we do not have enough subjects to make robust cross-linguistic comparisons, the most errors were made by the French speaker, which is consistent with what was expected because French was the only language tested that does not have foot structure. They are having to acquire a new structure in their L2 English.

The female German speaker had been in Canada for the shortest period of time and still performed as well as the male German speaker who had been in Canada for the longest period. This is consistent with hypothesis 2 as well since German foot and stress structure is the most like English. The equal performance of these two subjects shows that this ability is not something found only after lengthy exposure to L2 English.

We should also note that since none of French, Mandarin or German allow any infixing, it is not the case that these speakers are transferring L1 infixing knowledge to make L2 grammaticality judgments; this is something they have acquired in their second language.

6 Conclusion

Given that recursion is a central property of grammar (Watamull, Hauser, Roberts, & Hornstein, 2014), only humans have merge (Yang, Crain, Berwick, Chomsky & Bolhuis, 2017) and humans are usually bilingual, the default assumption should be that interlanguages have recursion, and our data confirm this hypothesis.

The L2 speakers were able to correctly judge the grammaticality of expletive infixing, and whether their L1 had feet seemed to play a part in how accurate they were. This leads to the conclusion that interlanguage grammars have a recursive structure contra the claims of Clahsen and Felser (2017).

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Appendix A

Stimuli list:

(1)		**Fantastic**	(2)		**Kindergarten**
	a.	Fantas-fucking-tic		a.	Kindergar-fucking-ten
	b.	Fan-fucking-tastic		b.	Kinder-fucking-garten
(3)		**Everybody**	(4)		**Scarborough**
	a.	Every-fucking-body		a.	Scar-fucking-borow
	b.	Everybo-fucking-dy		b.	Scarbo-fucking-row
(5)		**Unbelievable**	(6)		**Irresponsible**
	a.	Unbelieve-fucking-able		a.	Irrespons-fucking-ible
	b.	Unbe-fucking-lievable		b.	Irre-fucking-sponsible
(7)		**Vancouver**	(8)		**Garibaldi**
	a.	Vancou-fucking-ver		a.	Gari-fucking-baldi
	b.	Van-fucking-couver		b.	Garibal-fucking-di
(9)		**Nanaimo**	(10)		**Adventure**
	a.	Na-fucking-naimo		a.	Adven-fucking-ture
	b.	Nanai-fucking-mo		b.	Ad-fucking-venture
(11)		**Winnipeg**	(12)		**Saskatoon**
	a.	Winni-fucking-peg		a.	Saska-fucking-toon
	b.	Wi-fucking-nnipeg		b.	Sa-fucking-skatoon
(13)		**Mississauga**	(14)		**Celebrate**
	a.	Missi-fucking-sauga		a.	Celebra-fucking-te
	b.	Missisau-fucking-ga		b.	Cele-fucking-brate
(15)		**Pollution**	(16)		**Basketball**
	a.	Po-fucking-llution		a.	Basket-fucking-ball
	b.	Pollu-fucking-tion		b.	Bas-fucking-ketball
(17)		**Identical**	(18)		**Information**
	a.	Iden-fucking-tical		a.	Informa-fucking-tion
	b.	I-fucking-dentical		b.	Infor-fucking-mation
(19)		**Watermelon**	(20)		**Burnaby**
	a.	Waterme-fucking-lon		a.	Burna-fucking-by
	b.	Water-fucking-melon		b.	Bur-fucking-naby
(21)		**Abbotsford**	(22)		**Coquitlam**
	a.	Abbots-fucking-ford		a.	Coquit-fucking-lam
	b.	Ab-fucking-botsford		b.	Co-fucking-quitlam

How amplitude influences Mandarin Chinese tone recognition in whisper

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This study investigates whether intensity affects listeners' identification of whispered Mandarin tones. Two alternative forced choice identification experiments of whispered Mandarin tones were designed. In Experiment 1, twenty triplets of commonly used Mandarin Chinese bisyllabic words served as stimuli: two otherwise identical-sounding words of different tones and a word with completely different tones as a filler. The intensity level of the stimulus was set to 50, 60, and 70 dB, which were amplitudes determined according to a pilot study. Response accuracies across different intensity levels were analyzed. The results showed a tendency: the higher the amplitude, the better the listeners' recognition of whispered Mandarin tone. However, the accuracies across different intensity levels are insignificantly different, and Experiment 2 was then carried out. Four quartets of bisyllabic non-words were designed to match one of the four tones. The same intensity levels from Experiment 1 were employed. Each syllable was normalized to 480 ms. The results show that higher amplitudes only yield better tone recognition of tone 4. However, the absence of main effect for Intensity for either experiment suggests that amplitude may not be the only factor in determining the identification of whispered tone in Mandarin Chinese.
Keywords: whisper; amplitude; tone recognition; Mandarin Chinese

1 Introduction

As the vocal folds do not vibrate in whisper, there is no F0, the crucial acoustic correlate of tone. Accordingly, tone is difficult for people to recognize in whisper. Both Jensen (1958) and Gao (2002) argued that semantic context plays an important role in tone perception in whisper. Tones of a pair of otherwise identical-sounding words in whispered Mandarin could not be easily distinguished from each other unless there is a context as a cue. In other words, if words are whispered in isolation, it could be a hard task to identify their tones.

Some researchers have focused on intensity and speech identification in either phonated or whispered speech. Zhang et al (2007) found that the sound intensity levels of five speech modes, including whispered, soft, neutral, loud and shouted, were greatly varied, and the mean amplitude could represent the speech mode. Whisper, which possessed the lowest intensity, increased the difficulty of the speaker identification test and led to the worst performance of subjects.

As for perceptual cues in whisper, while Liu et al. (2004) proposed that duration helps recognition of whispered tones, Chang et al. (2007) argued that since speakers do not exaggerate intensity differences or durations among tones in whispered speech, there is no information available about duration or intensity for listeners to identify tones in whisper as is the case in normal speech. In Tartter (1989), it was found that the intensity of burst was one of the differences between voiced and voiceless stops in whisper for the latter have double-spiked bursts. This could thus serve as a perceptual cue in distinguishing voicing in whispered speech. Even though intensity can be a cue, when amplitude and duration are both available, Mandarin listeners do not show a preference between using amplitude and duration to recognize tone in whisper (Li et al., 2015). Then if one of two hints is controlled, will listeners be forced to use the other as a basis for judgement? As such, the role of amplitude in whispered tone recognition remains unknown.

While the above-mentioned studies have contributed to the understanding of tone recognition in whisper, none of them focused on its relationship with intensity. This paper attempts to probe into the role amplitude plays in distinguishing tones in whispered Chinese words by addressing one research question: Does amplitude affect listeners' tone recognition of isolated Mandarin Chinese words in whisper? The hypothesis is that the higher the amplitude, the better the tone recognition. Two perception experiments were designed to test people's performance on recognizing tones of Chinese words at different amplitudes in whisper.

2 Experiment 1

2.1 Methods

2.1.1 Participants

Ten (7 male; 3 female) native speakers aged 21 to 25 of Taiwan Mandarin participated in the study. All speakers were naïve to the purposes of the study.

2.1.2 Materials

The materials were twenty triplets of commonly used Mandarin Chinese bisyllabic words whose amplitudes were normalized (Table 1). Each triplet was composed of three bisyllabic words: two were identical in segments, but not tone, and the third was a filler word. The fillers were words that never cause any lexical confusion in terms of tone. The materials were recorded by a male native speaker of Mandarin Chinese in the phonetics laboratory at National Taiwan University and then normalized to 50, 60, and 70 dB, which were amplitudes decided according to a pilot, in which three female native speakers of Mandarin Chinese joined and which was conducted in the same way as the experiment.

Table 1. Sixty bisyllabic words used as materials for Experiment 1.

20 Triplets of Commonly Used Mandarin Chinese Bisyllabic Words		
Otherwise identical-sounding words of different tones		Filler
睡覺 *Shuìjiào* "sleep"	水餃 *Shuǐjiǎo* "dumpling"	吃飯 *Chīfàn* "to eat"
研究 *Yánjiù* "research"	菸酒 *Yānjiǔ* "tobacco and liquor"	哲學 *Zhéxué* "philosophy"
失眠 *Shīmián* "insomnia"	市面 *Shìmiàn* "market"	網路 *Wǎnglù* "network"
符號 *Fúhào* "sign"	富豪 *Fùháo* "mogul"	手錶 *Shǒubiǎo* "watch"
話筒 *Huàtǒng* "microphone"	花童 *Huātóng* "page boy"	水壺 *Shuǐhú* "kettle"
香蕉 *Xiāngjiāo* "banana"	橡膠 *Xiàngjiāo* "rubber"	瓢蟲 *Piáochóng* "ladybug"
看書 *Kànshū* "to read"	砍樹 *Kǎnshù* "to cut trees"	道路 *Dàolù* "way"
亞洲 *Yàzhōu* "Asia"	壓軸 *Yāzhóu* "finale"	書本 *Shūběn* "book"
天空 *Tiānkōng* "sky"	填空 *Tiánkòng* "to fill in the blanks"	朋友 *Péngyǒu* "friend"
發展 *Fāzhǎn* "development"	罰站 *Fázhàn* "to stand as punishment"	單車 *Dānchē* "bicycle"
上海 *Shànghǎi* "Shanghai"	傷害 *Shānghài* "to hurt"	天氣 *Tiānqì* "weather"
國民 *Guómín* "people"	過敏 *Guòmǐn* "allergy"	畫面 *Huàmiàn* "picture"
鉛筆 *Qiānbǐ* "pencil"	錢幣 *Qiánbì* "coin"	遵守 *Zūnshǒu* "to obey"

港幣 *Gǎngbì* "Hong Kong dollar"	鋼筆 *Gāngbǐ* "pen"	冷氣 *Lěngqì* "air conditioner"
鳳梨 *Fènglí* "pineapple"	鋒利 *Fēnglì* "sharp"	鋼琴 *Gāngqín* "piano"
約分 *Yuēfēn* "reduction of a fraction"	月份 *Yuèfèn* "month"	總統 *Zǒngtǒng* "president"
威脅 *Wēixié* "threat"	猥褻 Wěixiè "obscene"	牛肉 *Niúròu* "beef"
緣故 *Yuángù* "reason"	遠古 *Yuǎngǔ* "ancient"	忙碌 *Mánglù* "busy"
國中 *Guózhōng* "junior high school"	過重 *Guòzhòng* "overweight"	標題 *Biāotí* "title"
貿易 *Màoyì* "trade"	毛衣 *Máoyī* "sweater"	青菜 *Qīngcài* "vegetable"

2.1.3 Procedure

A two-alternative forced-choice task was designed. The stimuli were randomly delivered through PsychoPy and the participants were instructed to identify the whispered tone combination. Two tone combinations were shown in Zhuyin tone markers and visually displayed on the left and right sides of the monitor in front of them. The participants were asked to respond by pressing "p" or "q" buttons as quickly and accurately as possible within a time window of 4 seconds. For example, if they heard "*Guózhōng*," " ˊ - " and " ˋ ˋ " would be shown on the monitor, and participant should choose " ˊ - ." The whole process would repeat once again after a short break as block 1 and block 2. Thus, a total of 360 trials = 3 stimuli * 20 triplets * 3 levels of amplitude * 2 blocks was included.

2.2 Results

Mean accuracy and standard deviation combining blocks 1 and 2 are presented in Table 2, with the highest accuracy of each subject marked in bold print. The mean accuracies at 50, 60, and 70 dB are 55% (SD = 5.6%), 57% (SD = 6.8%), and 58.8% (SD = 7.4%), respectively. Across the ten participants, six reached their personal highest accuracy score in response to 70 dB stimuli, four to 60 dB and two to 50 dB, with two people having the same score for both 60 dB and 70 dB.

Table 2. Individual subject's accuracies of tone recognition at different amplitudes in Experiment 1.

Subject	Mean accuracy	50 dB	60 dB	70 dB
1	48%	**50%**	46%	48.7%
2	52.5%	52.5%	51%	**53.7%**
3	55%	**56%**	55%	55%
4	59%	56%	**61%**	60%
5	65%	57.5%	67.5%	**71%**
6	55.8%	52.5%	**57.5%**	**57.5%**
7	52.9%	48.7%	**55%**	**55%**
8	51.6%	50%	51%	**53.7%**
9	66%	66%	62.5%	**71%**
10	63%	62.5%	**65%**	62.5%
Mean	57%	55%	57%	58.8%
SD	6.1%	5.6%	6.8%	7.4%

2.3 Discussion

The results of Experiment 1 show a tendency: the higher the amplitude, the better participants perform in tone recognition. In terms of individuals, there is a trend for the participants to reach their personal best accuracy scores at the higher amplitudes; in terms of the whole, the mean accuracy gets higher as the intensity level increases. Thus, it is shown that the subjects performed better when the amplitude was higher, suggesting an influential role of intensity level in whispered tone recognition. While the results reveal the tendency between the high stimulus intensity and the high identification accuracy, the differences between the accuracy across the three amplitudes were not significant. Between 50 and 60 dB, $p = 0.49$; between 60 and 70 dB, $p = 0.61$; between 60 and 70 dB, $p = 0.23$. Between the two blocks, $p = 0.32$. For all tests, $df = 9$, $a = 0.05$.

The current design only controlled two variables: the response time allowed (4 seconds for each stimulus) and the intensity levels (50, 60, and 70 dB). The insignificant differences may have resulted from several uncontrolled variables, including vowel quality, combination of tones, order of stimuli, and speech rate. The vowel qualities differ from stimulus to stimulus; possible tone combinations were not exploited in the current design; the speech rates of each stimulus sound were similar but not identical. All of the uncontrolled variables may also affect the results of the experiment. As such, it is unlikely that amplitude is the one and only factor that influences people's tone identification in whisper.

3 Experiment 2

To further explore which factors may influence tone identification in whisper, Experiment 2 was designed and conducted to examine the identification of tones at different intensity levels again. Different from Experiment 1, Experiment 2 focused on people's tone perception of the second syllable in whispered bisyllabic words, with amplitudes, durations, and tone combinations controlled.

3.1 Methods

3.1.1 Participants

Another 15 native speakers (5 male; 10 female) of Taiwan Mandarin were recruited (aged 18 to 24). All speakers were naïve to the purposes of the study.

3.1.2 Materials

The materials contain four quartets of Mandarin Chinese bisyllabic non-words to avoid lexical processing. The sound combinations include /tipa/, /tapi/, /pʰitu/, and /pʰuti/. Each quartet has one sound combination. For each stimulus of each quartet, the first syllable was always matched with Tone 1 whereas the second syllable was one of the four lexical tones (Tones 1 - 4). The first two quartets were designed to investigate the influence of vowel height in whispered tone recognition (with the contrast between [i] and [a] in the syllables), and the latter two, vowel frontness with the contrast between [i] and [u]. The materials were recorded by a male native speaker of Mandarin Chinese in the phonetics laboratory at National Taiwan University, and then normalized to 50, 60, and 70 dB, and 480 ms for each syllable.

3.1.3 Procedure

All setups were identical to those in Experiment 1 except that four possible tone combinations were provided this time. Participants were asked to identify the correct tone combination from four options by pressing one of the 1, 3, 7, 9 keys on the number pad. For example, if they heard "/tipa/," " - - ," " - ˊ ," " - ˇ ," and " - ˋ " would be shown on the monitor, and they should choose " - ˊ ." The whole process would repeat once again after a short break as block 1 and block 2. Therefore, there is a total of 192 trials = 4 sound combinations * 4 tone combinations * 3 levels of amplitude * 2 repetitions in one block * 2 blocks.

3.2 Results

Combining blocks 1 and 2, mean accuracy and standard deviation are presented in Table 3, with the highest accuracy of each subject marked in bold print. The mean accuracies at 50, 60, and 70 dB are 31% (SD = 11.6%), 32% (SD = 11.3%), and 34% (SD = 10.6%), respectively. Across the fifteen participants, six reach their personal highest accuracy score in response to 70 dB stimuli, five to 60 dB and five to 50 dB, with one person having the same score for both 60 dB and 70 dB.

Table 3. Individual subject's accuracies of tone recognition at different amplitudes in Experiment 2.

Subject	**Mean accuracy**	**50 dB**	**60 dB**	**70 dB**
1	45.3%	**51.6%**	39.1%	45.3%
2	29.7%	**32.8%**	29.7%	26.6%
3	30.7%	28.1%	26.6%	**37.5%**
4	32.8%	29.7%	32.8%	**35.9%**
5	44.8%	40.6%	**48.4%**	45.3%
6	12.5%	7.8%	12.5%	**17.2%**
7	26.0%	26.6%	**28.1%**	23.4%
8	44.3%	**45.3%**	43.8%	43.8%
9	52.1%	46.9%	**56.3%**	53.1%
10	33.9%	26.6%	32.8%	**42.2%**
11	28.7%	**31.3%**	26.6%	28.1%
12	24.5%	17.2%	26.6%	**29.7%**
13	21.9%	**26.6%**	18.8%	20.3%
14	31.8%	26.6%	**39.1%**	29.7%
15	25.0%	21.9%	**26.6%**	**26.6%**
Mean	32%	31%	32%	34%
SD	10.5%	11.6%	11.3%	10.6%

An ANOVA with sphericity corrections was conducted to examine the effect of tone and intensity. No effects for Tone and Intensity were found (both $p > .05$), whereas the interaction between Tone and Intensity was significant ($p < .01$). The post-hoc analyses (Tukey HSD) reported that the Tone*Intensity interaction was driven by the significant rise for Tone 4 from 50 to 70 dB ($p<.001$).

The accuracies of each tone at each amplitude are shown in Figure 1. Among the four tones, only Tone 4 shows the expected pattern: the higher the amplitude, the higher the accuracy.

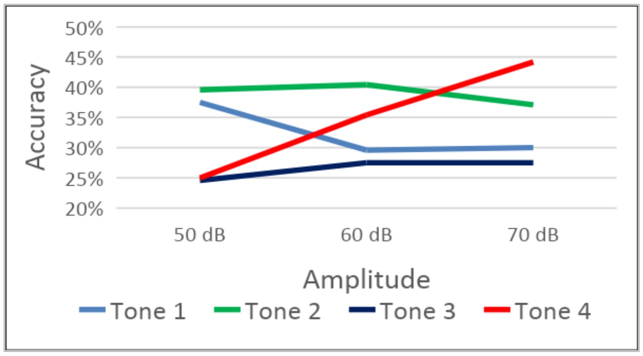

Figure 1. Accuracies of each tone at each amplitude in Experiment 2.

Furthermore, the proportions of each tone in response to each target tone at different intensity levels are also shown in Figures 2 to 4. The highest proportion was marked in bold print. At 50 dB, when the target tone was Tone 1 and 2, the responses that matched the correct tones have the largest response proportion; when Tone 3 and 4 were presented, the largest response proportion for Tone 1 was reported. At 60 dB, when the target tone was Tone 2 and 4, the tone-matched responses have the largest response proportion; when Tone 1 and 3 were presented, the largest response proportion for Tone 2 and 1 were reported. At 70 dB, the highest proportion was found for each tone-matched response.

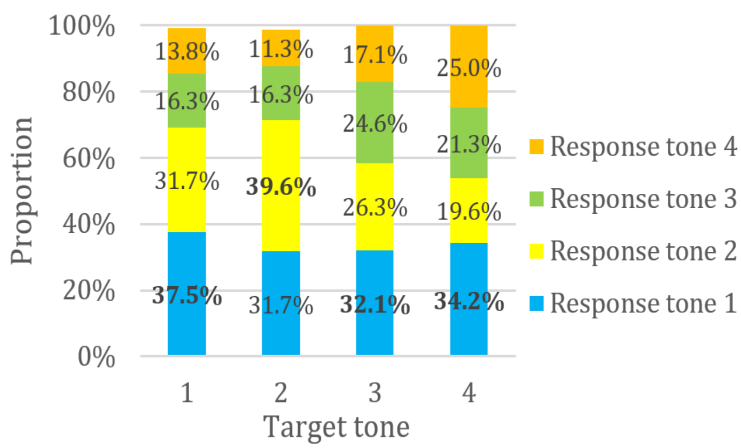

Figure 2. Proportion of each response tone in each target tone at 50 dB.

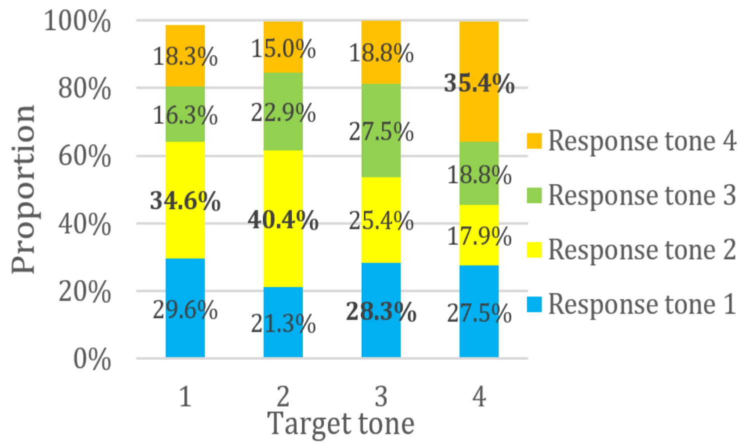

Figure 3. Proportion of each response tone in each target tone at 60 dB.

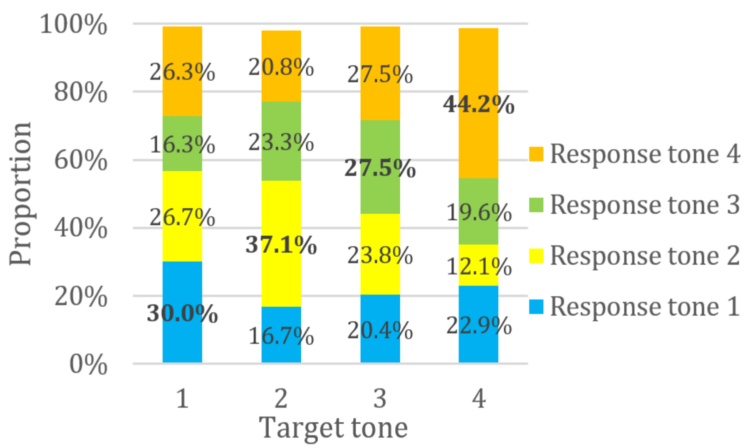

Figure 4. Proportion of each response tone in each target tone at 70 dB.

3.3 Discussion

The results of Experiment 2 show the tendency as Experiment 1: the higher the amplitude, the better participants perform in tone recognition. Similar to Experiment 1, there is a trend for the participants to reach their personal best accuracy scores at the higher amplitudes, and the overall mean accuracy gets higher as the intensity level increases. Figure 2 to 4 also show that the response proportion is positively matched with the target tone when the intensity of the stimulus increases. Collectively, the results suggest that the amplitude appears to be influential in whispered tone identification.

As revealed in the results, no main effect for Intensity was found. Possible factors include the number of response choices, normalized duration, and the use of non-word stimuli. Four options were provided in this experiment, which were twice more than those in Experiment1. This could potentially cause identification difficulty. Besides, as duration serves as a hint in tone recognition (Liu et al., 2004), the lack of duration difference among syllables could also make the task more challenging. In addition, in Experiment 1, the identification might be associated with lexical decision while Experiment 2 only provided non-words, which involved only low-level tone identification. These changes could potentially be responsible for the lower accuracy reported and the absence of main effect for Intensity.

The interaction between Tone and Intensity indicates that the performance of one tone or one intensity is different from that of others. As revealed in Figure 1, the different performance was associated with Tone 4, confirmed with the post-hoc analyses (Tukey HSD). Only Tone 4 shows the obvious tendency: the higher the amplitude, the higher the accuracy of tone recognition.

4 General Discussion and Conclusion

This research probes into how amplitude influences tone recognition in whispered Mandarin Chinese. As there is no vibration of the vocal folds in whisper, tone is hard to recognize. Jensen (1958) also argued that if there is no context as a cue, tones of a pair of otherwise identical-sounding words in whispered Mandarin could not be easily distinguished from each other. Besides, duration helps recognition of whispered tones (Liu et al., 2004), while the role of amplitude in whispered tone recognition remains unknown.

This present study proposed one research question: Does amplitude affect listeners in tone recognition of whispered Mandarin Chinese? Two perception experiments were conducted. In Experiment 1, twenty triplets of commonly used Mandarin Chinese bisyllabic words served as stimuli: two otherwise identical-sounding words of different tones and a word with completely different tones as a filler. The intensity level of the stimulus was set to 50, 60, and 70 dB, which were amplitudes determined according to a pilot study. Response accuracies across different intensity levels were analyzed. The results showed a tendency: the higher the amplitude, the better the listeners in whispered Mandarin tone recognition. However, the accuracies across different intensity levels are insignificantly different. Experiment 2 was designed to examine whether the identification of tones has different sensitivity to the intensity level in whisper. Four quartets of non-words were designed to match one of the four tones. The same intensity levels from Experiment 1 were employed and duration of each syllable was set to 480 ms. The results show that higher amplitudes only yield better tone recognition of tone 4, which is a surprising fact and can bring further investigation. However, the absence of main effect for Intensity for either experiment suggests that amplitude may not be the only factor in determining the identification of whispered tone in Mandarin Chinese.

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