Cross-dialectal influence in bilectal processing: Evidence from Norwegian ERPs

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1 Background

This project explores BILECTALISM and bilectal processing

> **BILECTALISM**: refers to a context where individuals – bilectals – acquire two (vernacular) varieties (e.g., Northern and Western Norwegian) and/or one or more written varieties of the same language (e.g., Norway's two official written varieties, Nynorsk and Bokmål)

1.1 Norwegian bilectalism

Bilectals acquire linguistic systems which are alike in most domains but which can vary in lexicon, morphosyntax, and/or phonology (1)

(1) **Lexical and grammatical variation in Bokmål, Sunnmøre, and Northern Norway**

jeg	tror	ikke	hund-ene	var	så	stor-**e**	**Bokmål**
ej	trukje		hund-ane	va	så	stor-**e**	**Sunnmøre Norwegian**
æ	tror	ikkje	hund-an	va	så	stor__	**Northern Norwegian**
I	believe	not	dog-DEF.PL.	were	so	big-PL./∅	

'I don't think the dogs were so big.'

Norwegian language users regularly face an extra-ordinary degree of bilectalism

- **in the spoken domain**: Norway lacks a standardised spoken dialect, and the use of regional dialects in all areas of one's life (including, e.g., national media) is the norm (Røyneland 2009) – contributing to regular exposure to other spoken dialects
- **in the written domain**: Norway features two official written varieties, Nynorsk and Bokmål, as well as use of so-called DIALECT WRITING (non-conventional written dialect, used in social media and other informal contexts, Røyneland and Vangsnes 2020) – all of which display significant lexical, graphophonological, and morphosyntactic differences and variation

Previous work

While there has been some neurolinguistic research on bilectalism (Kubota et al. 2023; García 2017; Garcia et al. 2022; Zaharchuk, Shevlin and van Hell 2021), most of this research has focussed on phonetic/phonological and semantic processing (e.g., Bühler et al. 2017; Goslin, Duffy and Floccia 2012; Lanwermeyer et al. 2016; Martin et al. 2016)

- ☞ we know relatively little about how bilectals represent and process grammatical differences between the different dialects they are exposed to
- ☞ we know especially little about how the brain processes morphosyntactic information in bilectal contexts, like the narrow grammatical variation in number agreement in (1)

Main Questions:

1. **What are the neurophysiological and behavioural correlates of bilectalism?**
   - do bilectals display distinct processing profiles depending on the dialect mode?
2. **What roles does grammatical similarity play in bilectal grammatical processing?**
   - how does typological proximity and grammatical contrastivity influence bilectals' behaviour and processing patterns?
3. **How are bilectal outcomes influenced by individual bilectal engagement and exposure?**
   - what extra-linguistic factors modulate individual differences in bilectal behaviours and outcomes?

1.2 The current study

The present study involves the juxtaposition of three ERP experiments, run in two dialect/variety modes (Bokmål and so-called Northern Norwegian Dialect Writing) and in two dialect regions with varying degrees of grammatical similarity to Bokmål (Sunnmøre [Western Norway] and Northern Norway), as outlined in Figure 1

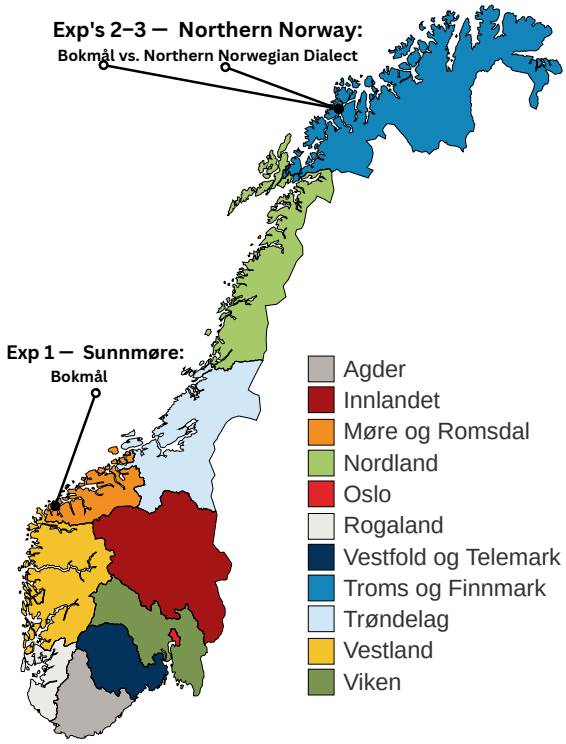


Figure 1: Bilectal test sites: *Experiment 1* – Sunnmøre: Bokmål; *Experiment 2* – Northern Norway: Bokmål; *Experiment 3* – Northern Norway: Northern Norwegian dialect writing

The study in a nut-shell:
ERP sentence processing experiments

- recorded from 32 active electrodes (ActiCap, Brain Products, Inc.) in accordance with the international 10–20 system
- sentences presented via rapid serial visual presentation (RSVP)

Conditions and design:

- long-distance gender and number agreement on predicate adjectives and participles
  - 30 items per non-/agreement condition (counterbalanced violation paradigm)
- grammaticality judgements per sentence
- cross-dialectal comparisons between experiments (n = 224)
  - ☞ Bokmål sentence processing in Sunnmøre (n = 73) vs. Northern Norway (n = 83)
  - ☞ Bokmål (n = 83) vs. Northern Norwegian (n = 66) sentence processing in Northern Norway

Bilectal engagement/exposure measures:

- locally adapted Sunnmøre Norwegian, Northern Norwegian, and Bokmål *Language Social Background Questionnaires* (Anderson et al. 2018) to map potential differences in engagement/exposure to the local dialect and/or Bokmål

1.2.1 Participants and conditions

The experiments were conducted with participants over 18 years of age, who have Norwegian as their first language – self-identifying as either Northern Norwegian or Sunnmøre Norwegian dialect speakers[1] – and who do not have known reading difficulties.

Group	n	Mean age (SD)	Min age	Max age
Northern Norway	83	37.4 (14.4)	18.1	68.8
Sunnmøre	73	42.8 (16.3)	20.0	80.2

Table 1: Age distributions of Northern Norwegian and Sunnmøre participants

The experiments consist of three conditions varying long-distance morphosyntactic agreement. The grammaticality of non-/agreement marking in these conditions varies across Norwegian varieties, as described in Table 2.[2]

- gender agreement is uniform across varieties (the control condition)
- grammatical alignment with Bokmål is varied/mismatched in the study's two target conditions
  - **note**: due to time and scope limitations, we will only focus on **Adj.gen** and **Adj.num** results in this presentation

[1] Because of known geographic variation in participial agreement in Sunnmøre, we additionally required that participants have grown up in one of the following Sunnmøre counties: Volda, Ørsta, Vanylven, Herøy, Ulstein, Hareid, Sande, Sykkylven or Stranda.

[2] *Eleven er frekk/frekt* 'the student is rude-M.Sg./N.Sg.'; *husene er fine/fin* 'the houses are nice-Pl./∅'; *lyktene er tente/tent* 'the lanterns are lit-Pl./∅'.

Condition	Agreement	Example	Bokmål	Sunnmøre Norw.	Northern Norw.
Adj.gen	agreement	*eleven er frekk*	✓	✓	✓
	non-agreement	*eleven er frekt*	×	×	×
Adj.num	agreement	*husene er fine*	✓	✓	×
	non-agreement	*husene er fin*	×	×	✓
Part.num	agreement	*lyktene er tente*	×	(✓)	×
	non-agreement	*lyktene er tent*	✓	(×)	✓

Table 2: Conditions – common gender agreement, unique number non-agreement in Northern Norw., and unique participial number agreement in Sunnmøre Norw.

Trial sentence design and presentation

An example structure of the trial sentences in Northern is illustrated in (2–5), contrasting grammatical number non-/agreement in Northern Norwegian and Bokmål in (4–5)

- the structure between conditions (gender, number) is identical
  - i.e., agreement is evaluated between the subject noun following the complementiser *at* and the predicate adjective following the past tense copula *var/va*
  - non-/agreement violations were instantiated on the adjective
  - note: violations only ever concern one feature (no double number + gender violations)
  - predicate adjectives/participles are followed by two to four words to control potential wrap up effects

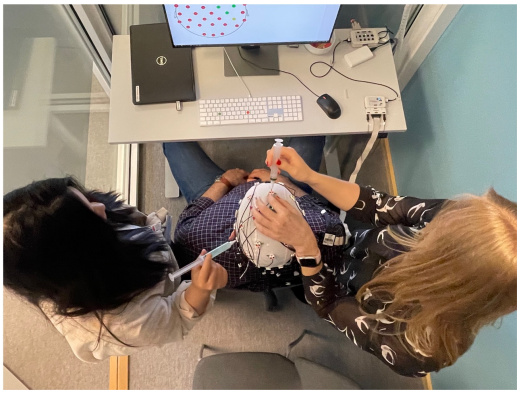
(2) **Bokmål** Liv fortalte meg at hunden hun trente var snill/*snilt mot barn
'Liv told me that the dog-M she trained was kind-M/*-N to kids'

(3) **Northern Norw.** Ho Liv fortalte mæ at hunden ho trænte va snill/*snilt mot unga
'Liv told me that the dog-M she trained was kind-M/*-N to kids'

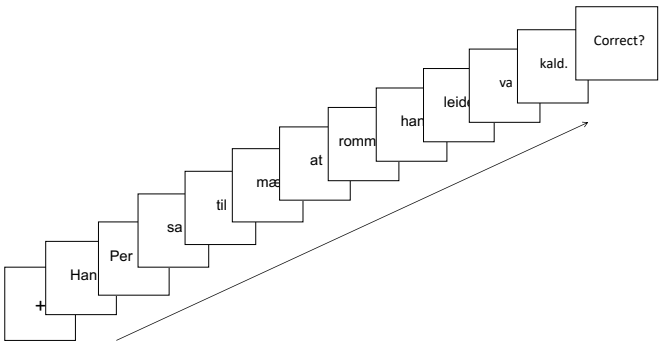
(4) **Bokmål** Tor viste meg at eplene han kastet var fulle/*full av mark
'Tor showed me that the apples he threw out were full-PL/*-∅ of worms'

(5) **Northern Norw.** Han Tor viste mæ at eplan han kasta va full/*fulle av mark
'Tor showed me that the apples he threw out were full-∅/*-PL of worms'

Sentences were presented in rapid serial word-by-word presentation at 450 ms intervals with grammaticality judgement tasks per trial (Figure 2)



(a) Capping a Northern Norwegian participant



(b) RSVP sentence presentation

Figure 2: Experimental design and sentence presentation

2 Experiments 1–2: Cross-dialectal influence on Bokmål sentence processing

Preview of Main Findings:

1. Grammatical similarity matters; contrasting grammatical patterns between varieties are associated with attenuated ERP amplitudes and decreased accuracy in GJTs

   ☞ Co-Activation of Bilectal Grammars / Cross-Dialectal Influence

2. Significant individual-level variation, relating to differences in individual bilectal engagement/exposure

   ☞ Exposure/Input Shapes Bilectal Outcomes and Behaviours

Overview: The Bokmål sentence processing experiments vary grammatical similarity between participants' spoken dialect and Bokmål (6)

- Sunnmøre Norwegian (control group): grammatically aligned with Bokmål
- Northern Norwegian (target group): grammatically misaligned with respect to predicate number agreement (see Table 2)

(6) **Contrasting number agreement in Bokmål, Sunnmøre Norwegian, and Northern Norwegian**

bilene er *rød/rød-e	**Bokmål**
bilane e *raud/raud-e	**Sunnmøre Norwegian**
bilan e rød/*rød-e	**Northern Norwegian**

'the cars are red-∅/Pl.'

2.1 ERP results

Grand average ERP waveforms from the predicate adjective gender and number conditions are presented in Figure 3

- **Gender**: as expected, lack of agreement elicited a large, broadly distributed positivity with a posterior maximum (a P600) among both Sunnmøre and Northern Norwegian participants (Figure 3)

  ☞ a common grammatical feature for all three varieties, no cross-dialectal influence

- **Number**: Sunnmøre participants show equally large P600 but Northern Norwegians show no effect of non-/agreement[3]

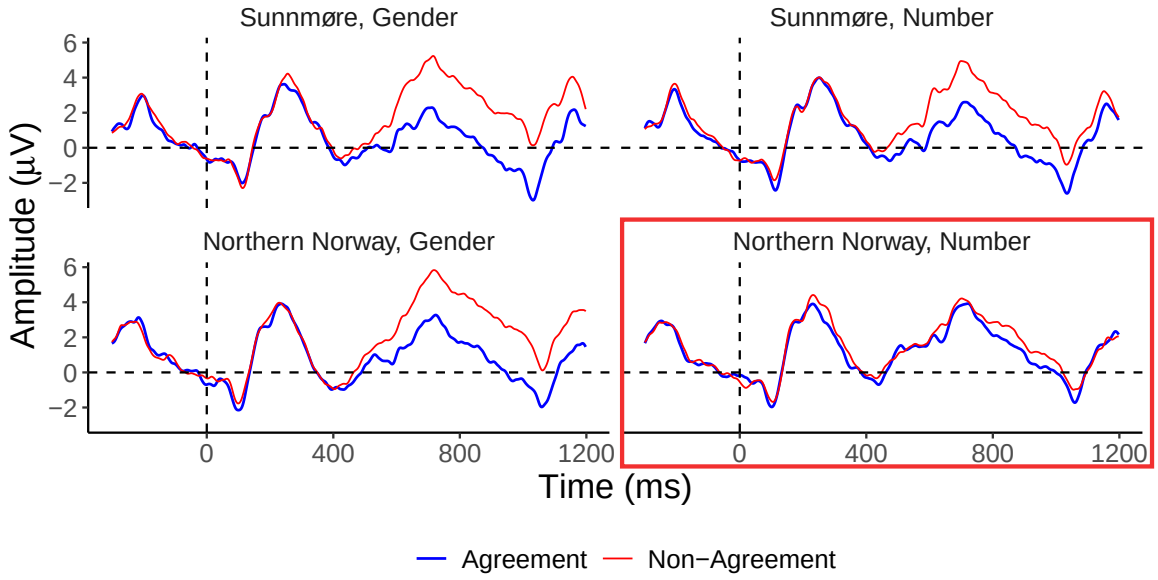


Figure 3: ERP waveforms recorded at electrode Pz for gender and number agreement among Northern Norwegian and Sunnmøre Norwegian participants while they read sentences with agreement (blue) and without agreement (red) in Bokmål. Mismatched grammaticality between Bokmål and Northern Norwegian number non-/agreement (the target condition) is highlighted in red.

2.1.1 Grammatical similarity and cross-dialectal influence

These differences seem to relate to competition between Northern Norwegian and Bokmål morphosyntax; Northern Norwegian *prohibits* number agreement while Bokmål *requires* it (mismatching grammaticality).

- Bokmål *bilene er røde/*rød* 'the cars are red-PL./∅'
- Northern Norw. *bilan e *røde/rød* 'the cars are red-PL./∅'

[3] A post-hoc pairwise comparison test reveals no significant different between Gender and Number conditions for Sunnmøre participants (estimate = −0.0652, SE = 0.277, z.ratio = −0.235, p = 0.8143). As with gender agreement, number agreement is obligatory in both Sunnmøre Norwegian and Bokmål; **non**-agreement is ungrammatical.

- Bokmål *bilene er røde/*rød* 'the cars are red-PL./∅'
- Sunnmøre *bilane e raude/*raud* 'the cars are red-PL./∅'

Cross-dialectal influence (CDI):
This means that sentences *with* and *without* agreement are grammatical and simultaneously ungrammatical for Northern Norwegians in one of their lects

☞ the Northern Norwegian ERP waveforms show a kind of *cancelling out*-effect of Northern Norw. and Bokmål grammar at the group level, attenuating non-/agreement processing differences (Cross-Dialectal influence)

2.1.2 Bokmål engagement/exposure

Figure 4 shows how amplitude is predicted modulated by individual engagement/exposure with Bokmål, using summed factor scores from the LBSQ relating to Bokmål engagement/exposure in social and area of use[4]

- **Sunnmøre**: as expected, no significant modulation by Bokmål exposure since both Sunnmøre dialects and Bokmål (and Nynorsk) all are grammatically aligned
- **Northern Norway**: bilectal engagement/exposure matters[5]

  ☞ greater engagement with Bokmål is associated with a more Bokmål-like P6 and, vice versa, lower use of Bokmål means increased influence of Northern Norwegian dialect on brain responses

  ☞ age shows similar modulations since the use of dialect writing is increasing, particularly among younger people due to increasing use of and exposure to social media (Vangsnes 2019; Røyneland and Vangsnes 2020; Hårstad 2021)

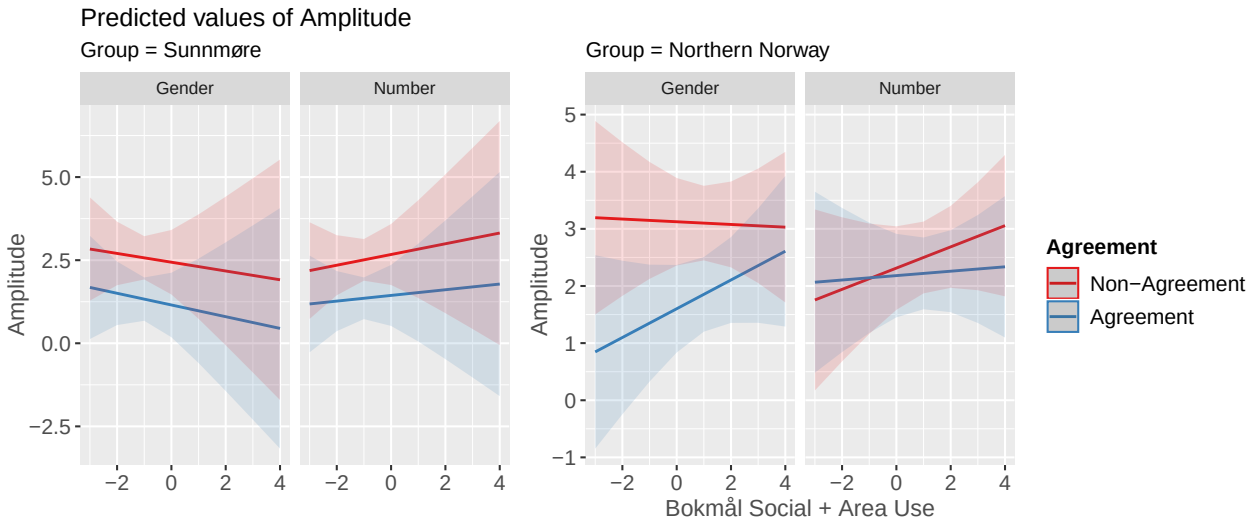


Figure 4: Predicted amplitude values for the interaction between ***Bokmål Social/Area Use*** × *Group* (Sunnmøre, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement)

[4]The amplitude prediction values here are calculated for the P600 window (500–900 ms) from a linear mixed effects model (LMM) investigating the relationship between mean *Amplitude* and dual four-way interactions contrasting subjects' Bokmål engagement/exposure and age. Specifically: Amplitude ~ scaled_age × Agreement × Condition × Group + Social_area × Agreement × Condition × Group + (1|Electrode) + (1 + Condition|Subject)

[5]Pairwise post-hoc tests show a near significant effect of Bokmål Social/Area Use (estimate = −0.1474, SE = 0.0594, z.ratio = −2.480, p = 0.063) and age (estimate = −0.3369, SE = 0.0817, z.ratio = −4.124, p = 0.0002) on number agreement ERPs. *Age* (z-score) broadly replicates the effects of *Social_area*.

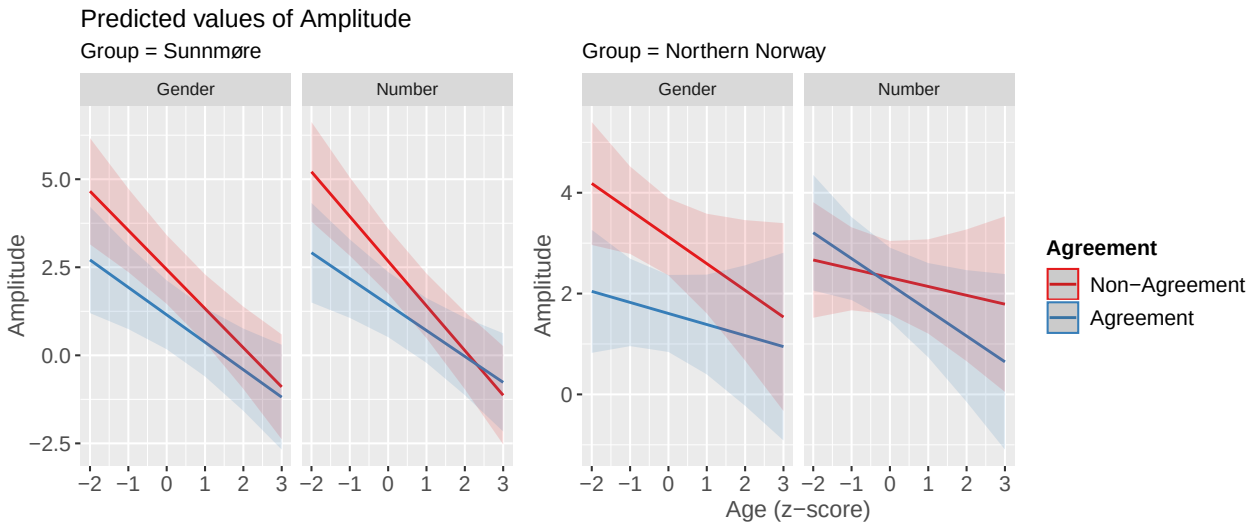


Figure 5: Predicted amplitude values for the interaction between ***Age* (z-score)** × *Group* (Sunnmøre, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement)

2.2 Behavioural results

Figure 6 provides group-level acceptance rates by group and condition

- **Gender**: as expected, both groups are accurate in accepting agreement and rejecting non-agreement trials

  ☞ a common grammatical feature for all three varieties, no cross-dialectal influence

- **Number**: Northern Norwegians are about twice as likely (mean = 0.62, sd = 0.49) to accept lack of agreement compared with the control group, Sunnmøre participants (mean = 0.32, sd = 0.47)

  ☞ mismatched grammaticality and cross-dialectal influence

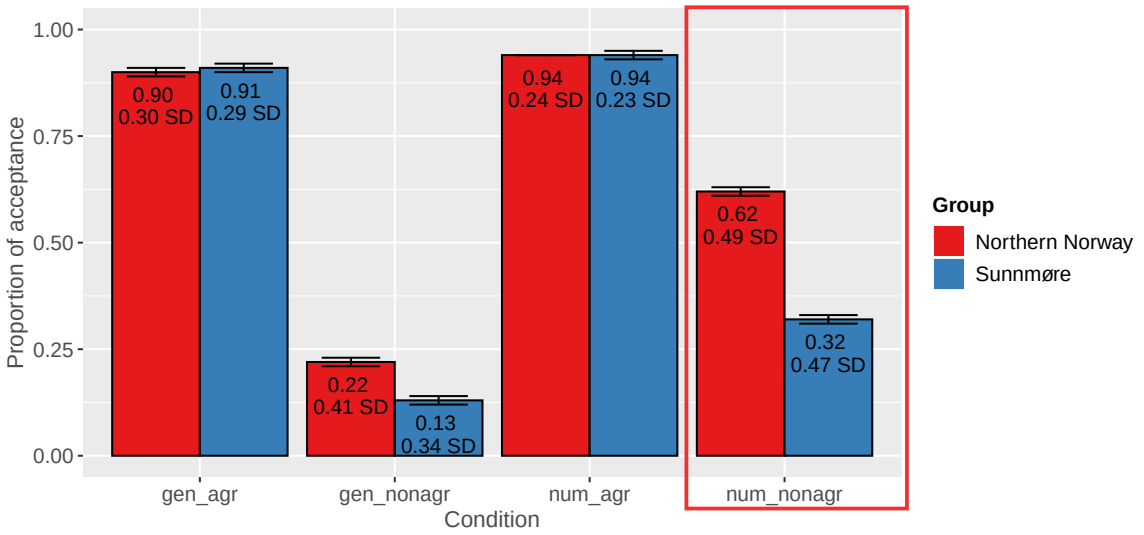


Figure 6: Grammaticality similarity effects on acceptance of number non-agreement in Bokmål. Group differences due to mis/matched grammaticality in Northern Norwegian vs. Sunnmøre groups is highlighted in red.

2.2.1 Bokmål engagement/exposure

Figure 7 shows how acceptance rates are predicted to be modulated by individual engagement/exposure with Bokmål, using summed factor scores from the LSBQ relating to Bokmål engagement/exposure in social and area of use[6]

- **Sunnmøre**: as expected, no significant modulation by Bokmål exposure since both Sunnmøre dialects and Bokmål (and Nynorsk) all are grammatically aligned
- **Northern Norway**: bilectal engagement/exposure matters[7]

  ☞ for number (target), greater engagement with Bokmål is associated with more accurate and more discrete results on GJTs, and, vice versa, lower use of Bokmål means increased gradience and decreased accuracy of grammaticality judgements

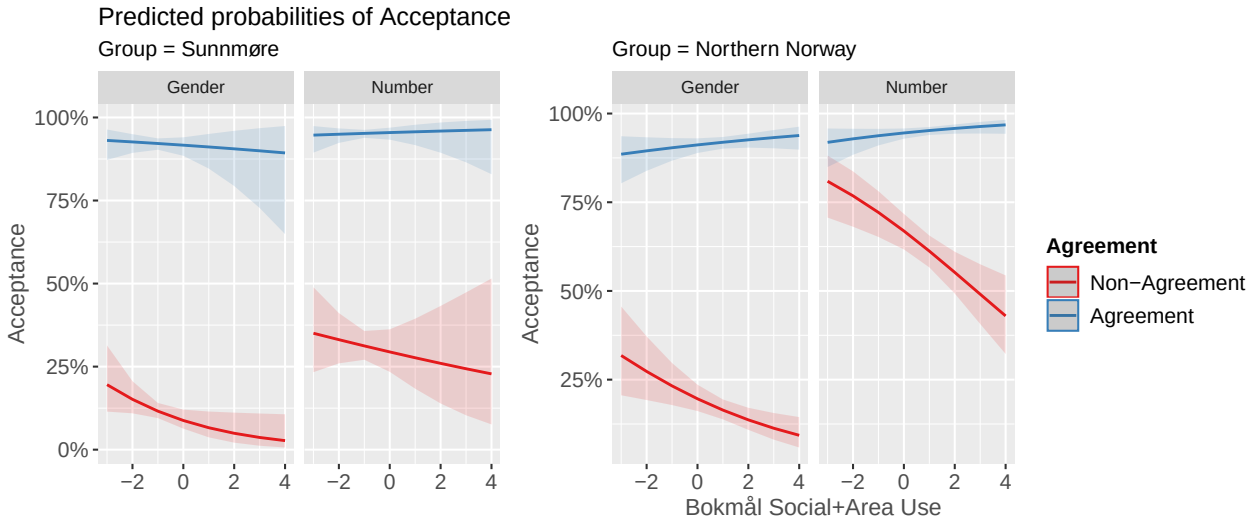


Figure 7: Predicted values illustrating the interaction between *Group* (Sunnmøre, Northern Norway) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement) × *Bokmål Social+Area Use* (Bokmål engagement/exposure) on grammaticality judgements (*Acceptance)*

[6]The acceptance prediction values here are calculated from a generalised linear mixed effects model (GLMM) investigating the relationship between grammatical judgements (*Acceptance*) and dual four-way interactions contrasting subjects' Bokmål engagement/exposure and age. Specifically: Acceptance ~ scaled_age × Agreement × Condition × Group + Social_area × Agreement × Condition × Group + (1 + Condition|Subject).

[7]Pairwise post-hoc tests reveal a significant effect of Bokmål Social/Area Use in our target condition for Northern Norway (estimate = −0.2851, SE = 0.0656, z.ratio = −4.347, p = 0.0001) but not for the control group: Sunnmøre (estimate = −0.2318, SE = 0.1394, z.ratio = −1.663, p = 0.3432). As shown in Figure 8, these results are replicated with *Age* (z-score) – again, because dialect writing is increasing especially in younger generations (leading to decreased Bokmål engagement/exposure in digital media).

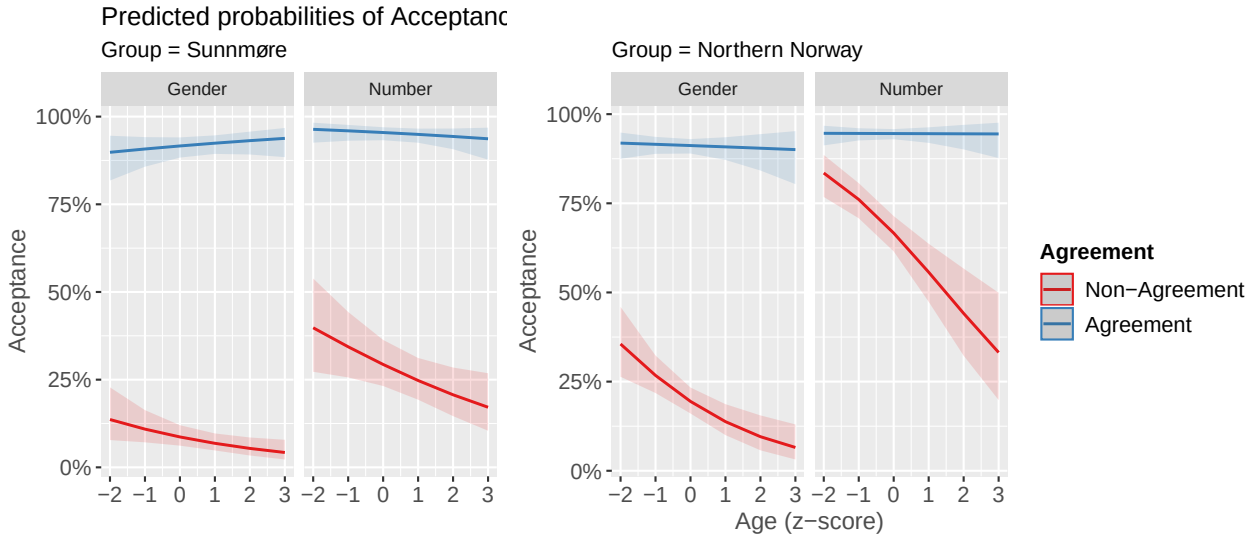


Figure 8: Predicted values illustrating the interaction between *Group* (Sunnmøre, Northern Norway) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement) × *Age* (z-score) on grammaticality judgements (*Acceptance)*

2.3 Summary of results

MAIN TAKE-AWAYS:

1. Grammatical similarity matters; contrasting grammatical patterns between varieties are associated with attenuated ERP amplitudes and decreased accuracy in GJTs

   ☞ CO-ACTIVATION OF BILECTAL GRAMMARS / CROSS-DIALECTAL INFLUENCE

2. Significant individual-level variation, relating to differences in individual bilectal engagement/exposure

   ☞ EXPOSURE/INPUT SHAPES BILECTAL OUTCOMES AND BEHAVIOURS

3 Experiments 2–3: Bilectal sentence processing

Preview of Main Findings:

1. Bilectals adjust their processing strategies depending on the dialect/variety input

   ☞ DISTINCT BILECTAL GRAMMATICAL REPRESENTATIONS

2. Mutual cross-linguistic influence in both Bokmål/Northern Norwegian dialect modes

   ☞ CO-ACTIVATION OF BILECTAL GRAMMARS / CROSS-DIALECTAL INFLUENCE

3. Significant individual-level variation, relating to differences in individual bilectal engagement/exposure

   ☞ EXPOSURE/INPUT SHAPES BILECTAL OUTCOMES AND BEHAVIOURS

Overview: In these experiments, Northern Norwegian participants are tested in two sessions (Bokmål vs. Northern Norwegian dialect writing) to test to what extent bilectal language users display distinct processing profiles depending on the dialect mode (7)

- Northern Norwegian dialect: participants' first language
- Bokmål mode: grammatically misaligned with respect to predicate number agreement (see Table 2)

(7) **Contrasting number agreement in Bokmål and Northern Norwegian**

bilene er *rød/rød-e **Bokmål**
bilan e rød/*rød-e **Northern Norwegian**
'the cars are red-∅/PL.'

3.1 ERP results

Grand average ERP waveforms from the predicate adjective gender and number conditions are presented in Figure 9

- **Gender**: predictably, non-agreement elicited a large P600 in both modes (Figure 9)
  - ☞ a common grammatical feature for both Bokmål and Northern Norw. varieties, no cross-dialectal influence
- **Number**: ERP amplitudes are attenuated in both dialect modes, but they show reversed P600 effects – associated with non-agreement in the Bokmål mode but agreement in the Northern Norw. dialect mode[8]
  - ☞ mutual cross-dialectal influence
  - ☞ distinct grammatical representations

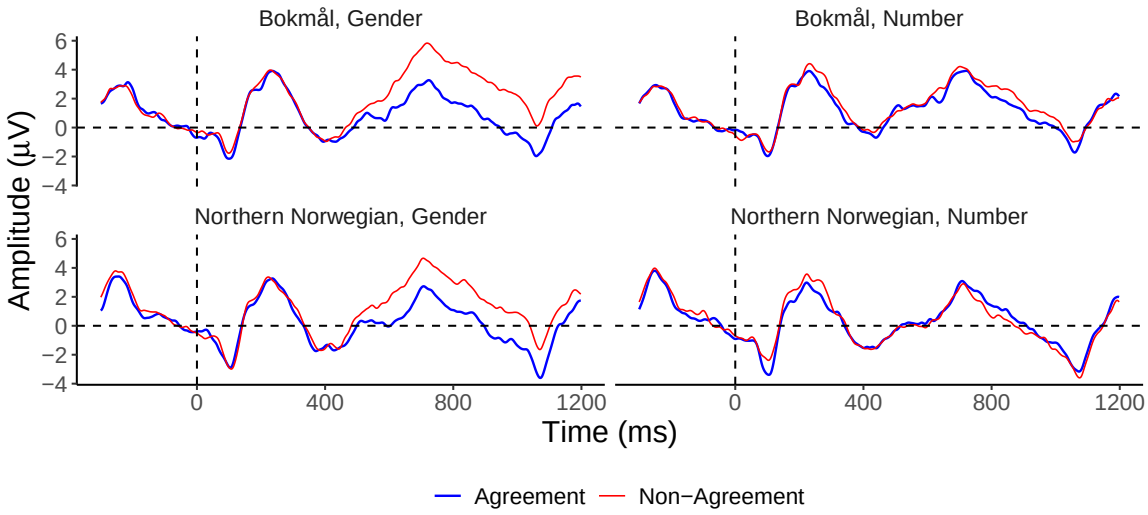


Figure 9: ERP waveforms recorded at electrode Pz for gender and number agreement among Northern Norwegian participants while they read sentences with agreement (blue) and without agreement (red) in Bokmål and Northern Norwegian dialect modes.

3.1.1 Bokmål engagement/exposure

Figures 10–11 show how amplitude is predicted to be modulated by age and individual engagement/exposure with Bokmål.[9]

[8]Post-hoc pairwise comparison tests reveal significant, reversed effects of non-/agreement in both dialect modes, as expected given their reversed grammaticality (**Bokmål**: estimate = −0.239, SE = 0.0773, z.ratio = −3.094, p = 0.002; **Northern Norwegian dialect**: estimate = 0.314, SE = 0.0832, z.ratio = 3.771, p = 0.0002).

[9]The amplitude prediction values here are calculated for the P600 window (500–900 ms) from a linear mixed effects model (LMM) investigating the relationship between mean *Amplitude* and dual four-way interactions contrasting subjects' Bokmål

- **Bokmål mode**: as before, these results suggest bilectal engagement/exposure modulates individual non-/agreement amplitudes in the number condition
- **Northern Norwegian mode**: Bokmål Social/Area use factor scores do not predict any modulations in the number condition and a spurious (unexpected) interaction in Gender

  ☞ here *Age* seems to provide a more stable (and more objective) measure (Figure 10), which predicts symmetric – though differentially scaled – significant influence of participants' age on number agreement processing in both Bokmål and Northern Norwegian dialect

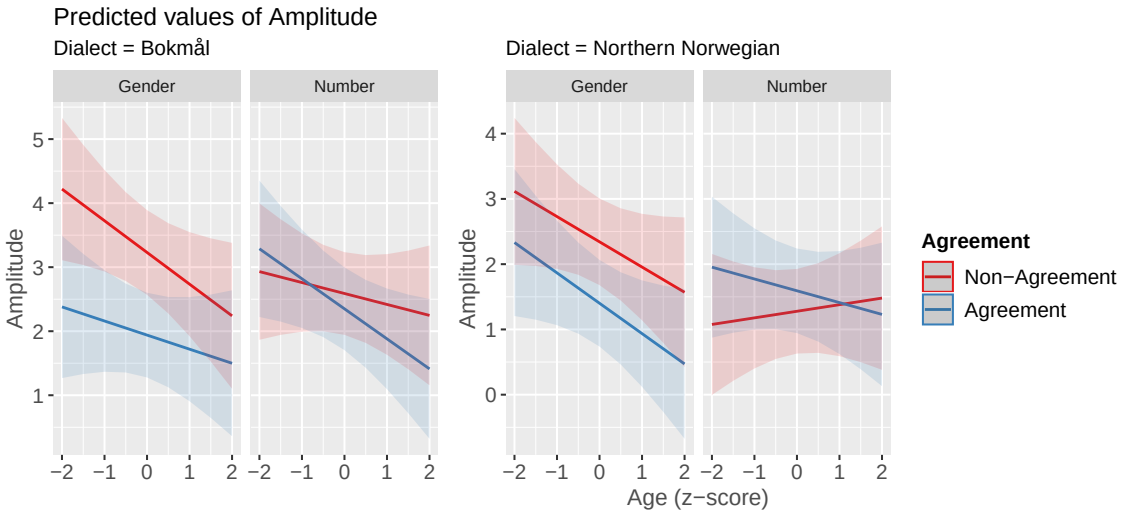


Figure 10: Predicted amplitude values for the interaction between ***Age* (z-score)** × *Dialect* (Bokmål, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement)

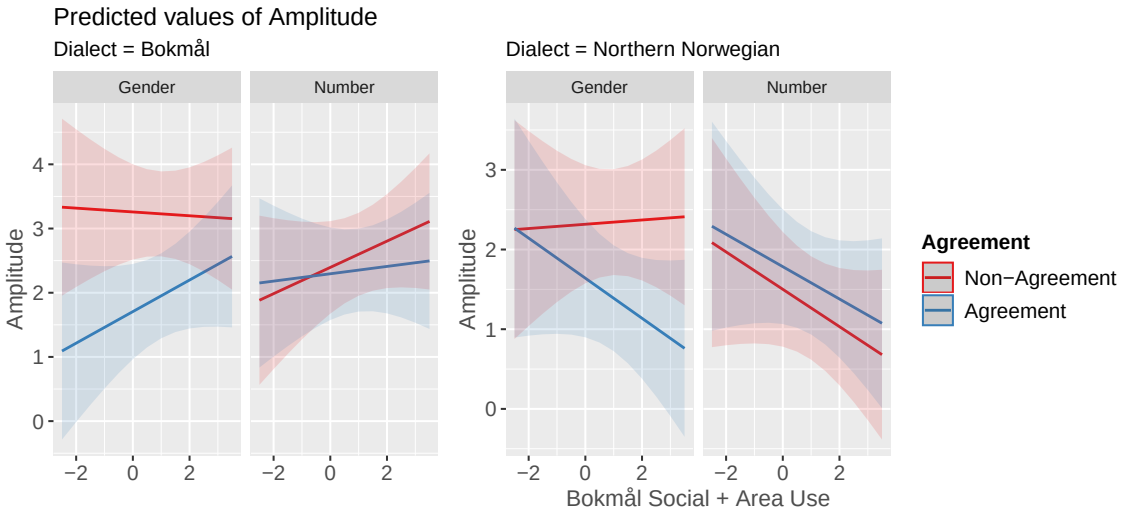


Figure 11: Predicted amplitude values for the interaction between ***Bokmål Social/Area Use*** × *Dialect* (Bokmål, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement)

3.2 Behavioural results

Figure 12 provides group-level acceptance rates by dialect mode and condition

- **Gender**: as expected, Northern Norwegian participants are equally accurate in accepting agreement and rejecting non-agreement trials

engagement / exposure and age. Specifically: Amplitude ~ scaled_age × Agreement × Condition × Dialect + Social_area × Agreement × Condition × Dialect + (1|Electrode) + (1 + Condition|Subject)

☞ a common grammatical feature for both Bokmål and Northern Norwegian dialect

- **Number**: grammaticality judgements are reversed, but they show little discrimination of non-/agreement grammaticality in either variety[10]

☞ mismatched grammaticality and cross-dialectal influence

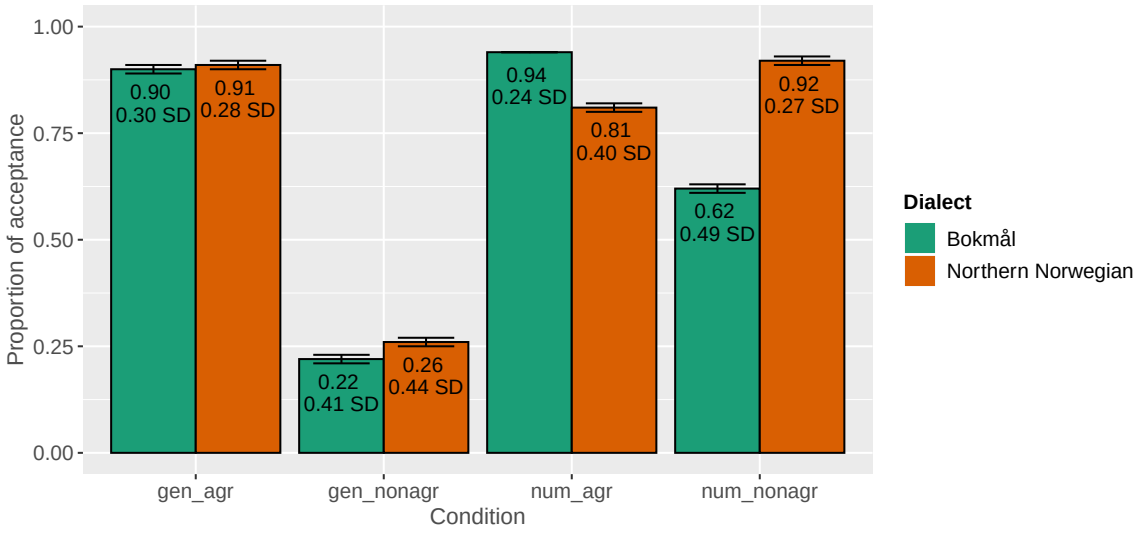


Figure 12: Grammaticality similarity effects on acceptance of number non-agreement in Bokmål vs. Northern Norwegian dialect writing.

3.2.1 Bokmål engagement/exposure

Figures 13–14 show how acceptance rates are predicted to be modulated by individual age and engagement/exposure with Bokmål

- **Bokmål mode**: as previously observed, Northern Norwegian's grammaticality judgements are significantly influenced by both age and Bokmål engagement/exposure in a similar way (revealing again the general trend in increasing dialect writing frequency among younger generations)
- **Northern Norwegian mode**: number grammaticality judgements are reversed (higher acceptance of agreeing trials), but non-/agreement differences are only weakly differentiated.[11]

☞ significant cross-dialectal influence but less variance in participants' native dialect

[10] These results are closely replicated in Kubota et al. (2023).

[11] Pairwise comparison tests show significant modulations by *Age* (estimate = 0.4594, SE = 0.1189, z.ratio = 3.863, p = 0.0006) but not by Bokmål Social/Area Use measures in the Northern Norwegian dialect mode (estimate = −0.1242, SE = 0.0822, z.ratio = −1.511, p = 0.4311).

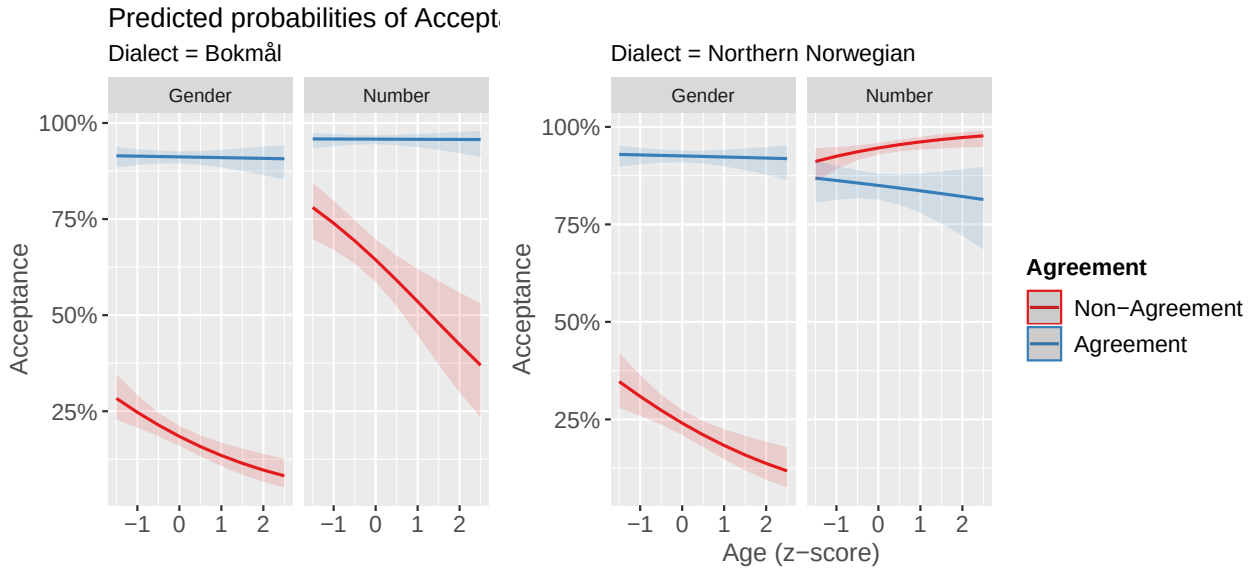


Figure 13: Predicted values illustrating the interaction between *Dialect* (Bokmål, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement) × *Age* (z-score) on grammaticality judgements (*Acceptance)*

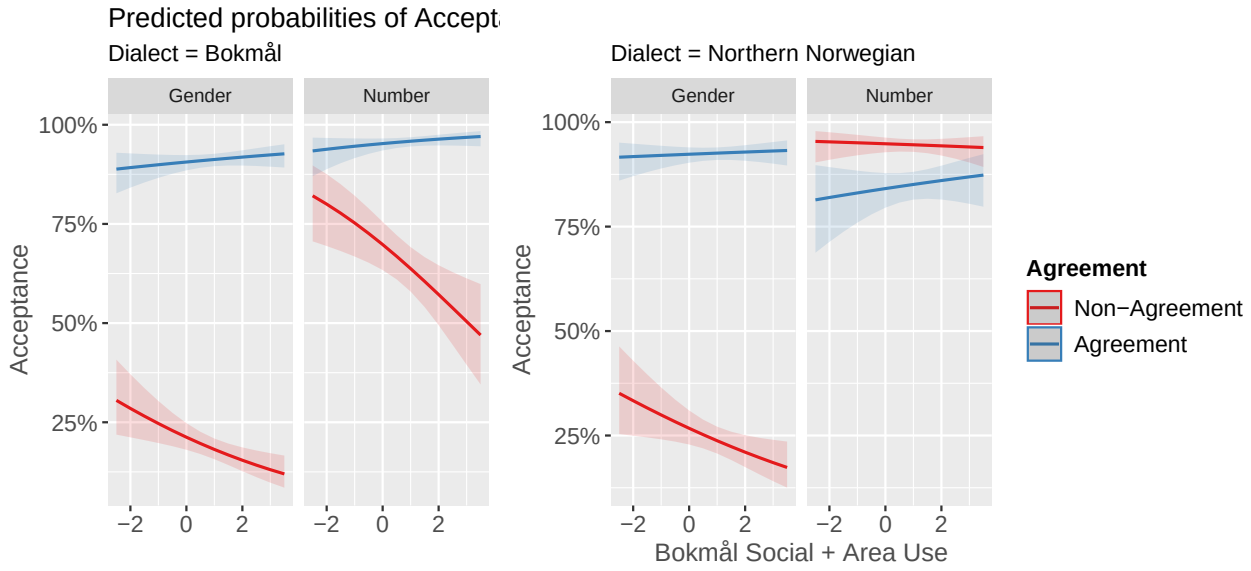


Figure 14: Predicted values illustrating the interaction between *Dialect* (Bokmål, Northern Norw.) × *Condition* (Gender, Number) × *Agreement* (Agreement, Non-Agreement) × *Bokmål Social+Area Use* (Bokmål engagement/exposure) on grammaticality judgements (*Acceptance)*

4 Summary

Bilectalism is a proper sub-case of bilingualism:

1. Bilectals adjust their processing strategies depending on the dialect/variety input

   ☞ Distinct Bilectal Grammatical Representations

2. Bilectals display mutual cross-linguistic influence in both Bokmål/Northern Norwegian dialect modes

   ☞ Co-Activation of Bilectal Grammars / Cross-Dialectal Influence

3. Bilectals display significant individual-level variation, relating to differences in individual linguistic engagement/exposure

   ☞ Exposure/Input Shapes Bilectal Outcomes and Behaviours

4. Bilectal sentence processing underlines the importance of considering individual-level (group-internal) variation

   ☞ Individual Differences in MultiLingualism/MultiLectalism

ERP results summarised

Figure 15 summarises the three experiments' ERP results using ERP difference waves (Non-Agreement − Agreement), isolating the components each group's non-/agreement processing differences in both dialect modes

For the number (target) condition:

- **Sunnmøre mode**: high positive amplitude (P600), no contrastivity with Bokmål (no cross-dialectal influence)
- **Northern Norway – Bokmål mode**: positive but weakened amplitude (attenuated P600) due to mismatching grammaticality between participants' spoken dialect and Bokmål
- **Northern Norway – Northern Norwegian mode**: negative and weakened amplitudes due to reversed *and* mismatched grammaticality betwen participants' spoken dialect and Bokmål

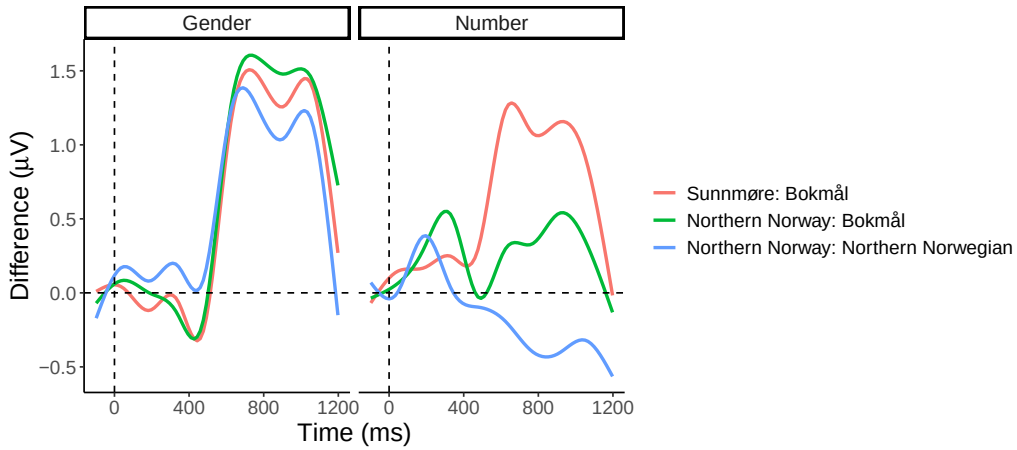


Figure 15: Group × Dialect ERP difference waves (Non-Agreement − Agreement) demonstrating the effect of grammatical similarity and reversed grammaticality in number agreement processing

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