Sociolinguistic Variation in Mouthings in British Sign Language (BSL): A Corpus-Based Study

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Abstract

Mouth activity forms a key component of all sign languages. This can be divided into ‘mouthings’, which originate from words in the matrix spoken language, and ‘mouth gestures’, which don’t. This study examines the correlation between the distribution of mouthings on verbs in BSL and various linguistic and social factors, using the BSL Corpus. While we find a strong association between production of plain verbs (which are body-anchored and cannot be modified) and increased mouthing, we observe only weak effects of gender (women mouth more than men) and region (signers from the south of the UK mouth more than those from the north). We find no significant effect of age or language background. Having observed considerable variation between participants and a lack of homogeneity in mouth activity on particular signs, we conclude that mouthings constitute code-blending between spoken and signed languages rather than being a compulsory part of the sign.

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Conventions

Lexicalised British Sign Language (BSL) signs are identified in this paper using their ID gloss (an English gloss that is used to uniquely identify a sign in its citation form or its morphological or phonological variants) in small capital letters. Their citation form can be found in the BSL Signbank http://bslsignbank.ucl.ac.uk; researchers can request access to this to search by ID gloss.

1 Introduction

Although sign languages are often considered to be simply languages of the hands, it is clear that many other articulators play key roles, including elements of the face plus the head and torso. The mouth is a key component; indeed mouth activity has been found in virtually all sign languages investigated to date (Johnston, van Roekel, & Schembri, 2016). Mouth activity has been found to emerge early in the development of new sign languages; for example Sandler (2012) found in her study of the newly-emerging Al-Sayyid Bedouin Sign Language that mouth gestures appeared before the systematic use of facial gestures or of the body and before independent use of the non-dominant hand. However, mouth activity is not found uniformly alongside all the manual signs in a sign language; whilst it occurs more frequently with nouns in many sign languages, its use accompanying verbs has been found to vary (see e.g. Bank, Crasborn, & van Hout, 2015; Johnston, Cresdee, Schembri, & Woll, 2015; Johnston et al. 2016; Penny Boyes Braem & Sutton-Spence, 2001). This is likely because nouns are generally less morphologically complex than verbs in sign languages (cf. Meir, 2012; Padden, 1983). This study investigates what social and linguistic factors affect co-occurrence of mouthing with verbs in British Sign Language (BSL), using the BSL Corpus (Schembri, Fenlon, Rentelis, & Cormier, 2014).

1.1 Introduction to Mouthings and Mouth Gestures

Mouth activity observed in signers can be divided into that which derives from the surrounding spoken language, known as ‘mouthing’, and that which does not, known as ‘mouth gesture’, as described in Boyes Braem and Sutton-Spence (2001). This study focuses on the
distribution of mouthings in BSL, although mouth gestures are also identified in the data so as to distinguish them from other types of (or no) mouth activity.

Mouthings have a variety of uses in sign languages. In many cases, they provide disambiguation between polysemous signs, where the same manual sign has several related meanings. For example, in Australian Sign Language (Auslan), the manual sign ROAD can mean ‘method’ or ‘way’ if accompanied by an appropriate mouthing (Johnston & Schembri, 2007).

In other cases, mouthings can disambiguate between manual homonyms in different semantic fields, such as AUNT (http://bslsignbank.ucl.ac.uk/dictionary/words/aunt-1.html) and BATTERY (http://bslsignbank.ucl.ac.uk/dictionary/words/battery-1.html) in BSL. Similarly they can be used to differentiate between fingerspelled abbreviations of English words that use the same letter or sequence of letters (Sutton-Spence, 1994), such as the BSL signs GARAGE (http://bslsignbank.ucl.ac.uk/dictionary/words/garage-1.html) and GEOGRAPHY (http://bslsignbank.ucl.ac.uk/dictionary/words/geography-1.html), which both involve a repetition of the fingerspelled letter -G-.

Additionally, mouthings may aid a signer who is not familiar with a particular regional sign to comprehend it (see Stamp (2016), for BSL). According to Boyes Braem (2001), this is also very common in Swiss German Sign Language (DSGS) because, as is the case for many sign languages, it has no standard form. This means that conversational partners often do not share the same lexicon of manual signs, so they use mouthings to exploit the fact that they do share the same matrix spoken language.

Mouthings may add semantic information; for example in Sign Language of the Netherlands (NGT) one may mouth the Dutch word for ‘bread’ at the same time as making the manual sign EAT to produce the meaning ‘eat bread’, as noted by Crasborn, van der Kooij, Waters, Woll, and Mesch

1 Fingerspelling is the use of specific signs to denote each letter of the alphabet in order to spell out English words.
Similarly, they can modify the meaning of adjectives or adverbs. For example, they can add intensity as in the mouthing of the German word for ‘very’ along with the manual sign **GOOD** in DSGS (Boyes Braem, 2001). Boyes Braem (2001) also notes that mouthings can occur without an accompanying manual sign in DSGS, either because of a lexical gap in the manual sign language or because of a gap in the signer’s knowledge of that language.

Finally, mouthings can be redundant in that they convey the same information as is provided by the hands (Ebbinghaus and Hessmann (2001) and Boyes Braem (2001)). As noted in Hohenberger and Happ (2001), there is a trade-off in all languages, spoken and signed, between redundancy on the one hand, which aids reliable communication, and economy on the other, which increases the speed of information exchange. It may be that in languages such as sign languages that have no written form and which are therefore more ephemeral, additional redundancy is encoded ‘in order to fix somehow the content of the utterance’ (Fontana, 2008:12).

Turning now to mouth gestures, these can be further subdivided based on their function, as described in Crasborn et al. (2008:49-51), into:

- **A-type**: Those that are adjectival or adverbial bound morphemes, such as the use of puffed cheeks to mean ‘big’;
- **E-type**: Mouth gestures which have no additional meaning and so are characterised as ‘semantically empty’, for example [ʃ] along with the manual sign **NOT-YET** (BSL) (cf. 'echo phonology' - Woll, 2001);
- **4-type** (‘mouth 4 mouth’): Enacting mouth gestures, such as chewing, accompanied by the manual sign **CHEW** (BSL);
- **W-type**: Mouth gestures that form part of the activity of the whole face, often when expressing emotion such as disgust.

Sometimes a given mouth gesture can have a variety of functions. For example the tongue protrusion [θ] in BSL can be semantically empty or act as an adverbial morpheme with a variety of meanings including ‘too easy’ and ‘lack of control’, as discussed by Lewin and Schembri (2011).
The distinction between mouthings and mouth gestures is not clear-cut, as pointed-out by Vogt-Svendsen (2001) and by Schermer (2001). The viewer’s previous experience will affect whether or not they perceive a given mouth pattern as derived from a word in the matrix language. For example, Siu (2007), in her investigation of mouth activity in Hong Kong Sign Language (HKSL), studied a deaf native signer, recording this informant’s own opinions as to whether her mouth actions were mouthings or mouth gestures. These did not always coincide with those of another deaf native HKSL user who acted as a reviewer.

It may be that some mouth actions originated as a mouthing but have changed over time to become a mouth gesture, as suggested by Vogt-Svendsen (2001), Ebbinghaus and Hessmann (2001), Keller (2001) and Siu (2007). This is difficult to prove because of the lack of written records of sign languages. Although pictures exist in print, it is hard to draw conclusions about mouth activity from these, meaning that it is only since the advent of film recording that dynamic mouth activity can really be studied.

1.2 Linguistic Status of Mouthings

All deaf communities exist in the context of larger hearing communities and so there is an inevitable influence of the matrix spoken language upon sign language. Indeed, mouthing persists even when native signers are conversing with one another with no hearing people present, as observed by Johnston et al. (2016) for Auslan.

The linguistic status of mouthings within sign languages has long been a topic of debate; see, for example, Boyes Braem and Sutton-Spence (2001). Some researchers (such as Sutton-Spence and Day (2001), Boyes Braem (2001), Ajello, Mazzoni, and Nicolai (2001), Rainò (2001) and Vogt-Svendsen (2001)) believe that although they originated as borrowings from the surrounding spoken language, some mouthings have become a compulsory, inherent part of the phonological/lexical specification of the sign they accompany.

In contrast, others, including Ebbinghaus and Hessmann (2001), Hohenberger and Happ (2001), Bank (2015), Johnston et al. (2016) and Giustolisi, Mereghetti, & Cecchetto (2017) believe
that mouthings are actually independent meaningful units that enhance the overall meaning of the utterance. They hold that the signer can (sub-consciously) select what mouth activity including mouthing to produce with each manual sign, in a process dubbed ‘code-blending’. This is supported by the findings of Bank, Crasborn, and van Hout (2011), who observed that in NGT, signers are not consistent in their temporal reduction of Dutch words when mouthing, and by Johnston et al. (2016), who found that mouthings in Auslan are not obligatory. Additionally, psycholinguistic research by Vinson, Thompson, Skinner, Fox, and Vigliocco (2010) suggests that manual signs and mouthings are represented separately in the brain.

1.3 Factors Affecting Rates of Mouthing

Various factors have been found to affect the rate of mouthing in sign languages. These include the type of situation in which the communication occurs (i.e. text type), and the morphological complexity of the corresponding manual sign. Additionally, social factors such as the region where the signer lives, their gender, age and whether they grew up with any deaf relatives (known as their language background) all may play a part. These will be discussed in turn, with reference to studies of different sign languages, each of which often considered several of the factors.

1.3.1 Text Type

Past research has found that the rate of mouthing differs by text-type. Sutton-Spence and Day (2001) analysed 7992 manual tokens of BSL in texts in what they termed ‘information register’ (formal interviews, television news interpreting and lectures) and in ‘narrative register’ (recounting a dramatic news story, telling personal narratives and retelling a fantasy story). They found that mouthing occurred on 77% of signs in the information register and 50%\(^2\) of signs in the narrative register. However, it is possible that these results could be skewed by the fact that the study involved quite different numbers of tokens and participants for each task, ranging from a single

\(^2\) There appears to be a discrepancy in their publication between this figure and the values in the corresponding table (page 80), which indicate that 60% of narrative signs are accompanied by mouthing.
television news interpreter providing 824 tokens to twelve participants retelling the fantasy story, producing 2210 signs between them.

Looking at other sign languages, Johnston et al. (2016) observed that there were significantly fewer mouthings in Auslan associated with narrative retellings (20.3% of tokens) compared with dialogues (68.6% of tokens). Although there was considerable variation between individuals in their study, almost all of the people who participated in tasks using more than one text-type showed more mouthings with dialogues than narratives, suggesting that the text-type difference is real. Similarly, Nadolske and Rosenstock (2007) studied 5785 manual tokens in American Sign Language (ASL) from three text types: story-telling, conversation and formal lecture. They also noted a lower occurrence of mouthings with narratives, observing their occurrence with 60% of signs in the conversation and formal lectures, but only with 42% of signs for the narratives. Furthermore, Sande and Crasborn (2009) found a significant difference between narrative and conversation text-types in a study of narrative retellings compared with spontaneous discussions in a sample of twelve signers taken from their corpus of NGT: 47% of mouth activity consisted of mouthings for the narratives, compared with 78% of mouth activity being mouthings in the conversations.

However, not all studies have found a difference based on text-type. Schermer (2001) compared the rate of mouthing of up to six participants undertaking different tasks in NGT. Out of 4279 tokens, she found that mouthing occurred with similar percentages of manual signs for all text-types, as follows: retelling two written stories (55.4% and 62.4%); retelling a picture story (46.6%); and free conversation with another deaf participant (51.3%). She suggests that this indicates that the Dutch words in the written stories and the presence of a deaf conversation partner do not greatly influence the rate of mouthing.

In summary, previous research has shown mouthing to be generally found less often in narrative compared to conversation text-types. This may be because narrative text-types, especially retellings, often include a relatively large amount of constructed action - i.e. enactment.
demonstrating actions of a referent (see Cormier, Smith, and Sevcikova-Sehyr (2015)). Mouth gestures are a key part of overt instances of constructed action (Johnston et al., 2016), meaning that fewer mouthings can co-occur.

1.3.2 Morphological Complexity

The current study focuses on mouthing co-occurring with verbs. In sign languages, verbs exhibit varying degrees of morphological complexity. Verbs have been categorised as plain, indicating or depicting. Plain verbs are those that are body-anchored and cannot be modified spatially. Indicating verbs can be directed spatially towards places, entities or directions (Liddell, 2003).\(^3\) Depicting verbs, also known as classifier verbs or classifier constructions, portray aspects of their meaning including features of the object that they are describing. Since plain verbs cannot be modified spatially, they are less morphologically complex than indicating or depicting verbs; they do not encode concepts such as the subject and object or source and goal of the verb within the sign. Hohenberger and Happ (2001) observe that in German Sign Language (DGS) it is not possible to mouth the full set of translation equivalents included in morphologically complex signs such as indicating and depicting verbs. Therefore, signers either produce no mouthing at all with these signs, or they mouth just the stem of the verb. Overall this reduces the frequency of mouthings on these more morphologically complex signs.

Evidence for this has been found in BSL and ASL. In the studies referenced above, Sutton-Spence and Day (2001) found that in BSL, only 23% of verbs associated with mouthings were morphologically complex, and Nadolske and Rosenstock (2007) observed that in ASL, mouthings occurred on 53% of plain verbs, 38% of indicating verbs and 7% of classifier verbs. Additionally, many of the studies reported in Boyes Braem and Sutton-Spence (2001) found a similar effect. For example, Vogt-Svendsen (2001) observed that mouthings occurred more on unmodified verbs than on indicating or depicting verbs in Norwegian Sign Language.

\(^3\) Liddell’s (2003) class of indicating verbs includes what Padden (1983) refers to as agreement or agreeing verbs, and also some spatial verbs (i.e. all spatial verbs aside from depicting/classifier verbs).
Johnston et al. (2016) also noted that previous research found more mouthing co-occurring with plain verbs as compared to indicating or depicting verbs. However, their own study of mouth activity in Auslan did not find this. They annotated 17002 manual tokens from 50 extracts from the Auslan Corpus, consisting of 25 monologue narrative retellings of Aesop’s fables, 15 elicited picture descriptions and 10 dialogues that were a mixture of free conversation and answers to interview questions. They found that indicating verbs patterned differently than had previously been observed, in that their rate of mouthing (36%) was actually slightly higher than with plain verbs (34%). Both of these were much higher than for depicting verbs (3%). This may be explained by the hypothesis of Cormier, Quinto-Pozos, Sevcikova, and Schembri (2012) that mouthing occurs more on lexical signs, since plain and indicating verbs are lexical whereas depicting verbs are not.

Overall, a pattern is clear across the range of languages discussed in this section, with higher rates of mouthing on morphologically simpler signs such as plain verbs, compared with morphologically more complex signs such as classifier constructions.

1.3.3 Social Factors

Social factors such as gender, age, ethnicity, region and social class are known to influence the general linguistic production of individuals - this is true for both spoken and signed languages (Lucas, 2001). The influence of social factors on mouthings is discussed below. Cross-linguistically, not all studies find that social factors are significant predictors. For example, the study by Johnston et al. (2016) referenced above did not find age, gender, language background or region to be significant predictors of mouthing in Auslan.

1.3.3.1 Region

Regional variation has been identified in BSL particularly in the lexicon (e.g. Stamp et al., 2014) and also in fingerspelling (Brown & Cormier, 2017; Sutton-Spence, Woll, & Allsop, 1990). There has been less research on regional variation in mouthing in BSL. Rentelis (2011) notes that the ‘folk wisdom’ amongst the British deaf community is that Scots use mouthing less than southern English signers. He investigated this using the BSL Corpus (see Section 3.1 below),
studying 500 verb tokens from each of London and Glasgow, and found that there was indeed a significant difference. Rentelis did not find a similar result for mouthings accompanying nouns, which is why the current study focuses on verbs. His study is relatively small in scale, and he does not provide details about how he selected which tokens to include or how he identified their grammatical category; this is not straightforward in sign languages as discussed in Section 3.2.1.

1.3.3.2 Gender

Rentelis' 2011 study also found that women produced significantly more mouthings than men accompanying verb tokens in the BSL Corpus. In countries such as Ireland with a different education policy whereby gender-segregation of deaf children has been the norm, gender differences in mouthing have also been observed. For example, Mohr (2012), also found a higher rate of mouthing in Irish Sign Language among women than men; she suggests that their different educational experience is the reason for the variation. However, in nations such as the Netherlands and Australia where there has been no educational segregation, no significant difference between males and females is found in mouthing (Bank, 2015; Johnston et al., 2016). Rentelis suggests that the gender difference found in BSL may be an effect of social class, citing Ladd (2003). We return to this issue in Section 5.2.

1.3.3.3 Age

An individual’s experience of English and BSL during their education is likely to affect their signing throughout their life. This will include their mouthing (Sutton-Spence and Day, 2001). In Stamp's (2013) study, she notes that the age of a signer can be used as a proxy for their education background, because of national changes in education policy over time. As described in Schembri, Fenlon, Rentelis, Reynolds, and Cormier (2013), despite the suppression of sign language in the classroom during most of the twentieth century in the UK, its use continued covertly. During the first half of the century deaf children were generally taught in specialised residential schools using a great deal of fingerspelling and speech-reading. After the Second World War, there was a greater emphasis on speaking and using residual hearing. Then later, schools for deaf children began to
close and pupils were instead educated in a mainstream setting. Sign-supported English (SSE\textsuperscript{4}) was introduced and individuals were offered improved hearing aids as technology advanced. Finally, those starting their education from approximately 1980 onwards were generally taught in mainstream schools with BSL interpretation. Some, however, were educated using BSL in schools that adopted a bilingual English/BSL approach.

Previous research has investigated the correlation between age and rate of mouthing in BSL. For example, Sutton-Spence and Day's 2001 research compared signers above and below the age of 40 at the time of filming, so born before/after approximately 1957. They did not find a significant difference, but perhaps this is not surprising since both these groups will have experienced a similar oral education in schools for the deaf. However, in another part of their study, they compared signers aged above and below 30 (born before/after 1967). This is approximately the age at which the older group will have been educated in schools for the deaf and the younger group in mainstream schools. The younger group produced more mouthings, although the differences were small. Rentelis (2011) did not find an effect of age on the degree of mouthings with verbs when examining the BSL Corpus. He categorised people into ‘young’ (born between approximately 1974 – 1991), ‘middle’ (born between around 1959 and 1973) and ‘old’ (born before 1959). His middle/old distinction is comparable to the above/below age 40 cut off used by Sutton-Spence and Day, and his findings are the same (i.e. no significant difference between those above/below this cutoff). However we cannot compare Sutton-Spence and Day's above/below age 30 result to Rentelis as he did not make a corresponding age split.

1.3.3.4 Language Background

A further social factor is ‘language background’, i.e. whether participants grew up with any signing close relatives or other care-givers from whom they acquired a sign language. This is relevant because only 5-10\% of deaf people acquire sign language from signing family members.

\textsuperscript{4} SSE combines signs with spoken English, using the grammar of spoken English rather than of BSL.
(Mitchell & Karchmer, 2004; Schembri et al., 2013), and the presence of signing relatives affects an individual’s exposure to BSL during their critical period for language acquisition (Mayberry, 2007). Sutton-Spence and Day (2001) state that Day (1995) found that signers without deaf relatives used BSL with more English influence. However their own research on BSL found no significant difference in the use of either mouthings or mouth gestures based on language background. Similarly, the other major studies on mouth activity in sign languages, including Rentelis (2011), Johnston et al. (2016) and Bank, Crasborn, and van Hout (2015) looked for but did not find variation based on language background of participants.

1.4 Cross-Linguistic Variation in Mouthing Proportions

Key studies into the rate of mouth activity in various sign languages, including those discussed above, are summarised in Table 1. Due to the different methodologies employed in each piece of research, direct comparison is not possible; some studies report the split of all mouth activity into mouthing and mouth gesture (Table 1, columns 3-4), whereas others report the percentage of manual signing that is accompanied by mouthing, mouth gesture or no mouth activity (Table 1, columns 5-7). Nonetheless it is evident that widely different results have been obtained, even within the same language. One reason for this may be differences in text-type; for example, the earliest study of NGT (Crasborn et al., 2008) found that only 46% of mouth activity was mouthing, whereas Bank (2015) found a rate of 85% in the same language. The first of these used a story retelling task whereas the second used conversation.

<table>
<thead>
<tr>
<th>Language</th>
<th>Study</th>
<th>% mouth activity overall</th>
<th>% of mouth activity w/manual signs</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mouthing</td>
<td>Mouth gesture</td>
<td>Mouthing</td>
</tr>
<tr>
<td>ASL</td>
<td>Nadolske and Rosenstock (2007)</td>
<td>-</td>
<td>-</td>
<td>42-60</td>
</tr>
<tr>
<td>Auslan</td>
<td>Johnston et al. (2016)</td>
<td>74</td>
<td>26</td>
<td>57</td>
</tr>
<tr>
<td>BSL</td>
<td>Crasborn et al. (2008)</td>
<td>64</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>BSL</td>
<td>Sutton Spence and Day (2001)</td>
<td>80</td>
<td>20</td>
<td>69</td>
</tr>
<tr>
<td>DGS</td>
<td>Ebbinghaus and</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 1: Cross-linguistic summary of percentage of mouth activity. Dashes indicate where data is not available. Figures for ‘% of mouth activity w/manual signs’ which do not total 100% are because some mouth actions in these studies could not be categorised.

<table>
<thead>
<tr>
<th>Language</th>
<th>Study</th>
<th>HKSL</th>
<th>LIS</th>
<th>NGT</th>
<th>SSL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hessmann (2001)</td>
<td>Siu (2007)</td>
<td>54</td>
<td>46</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ajello et al. (2001)</td>
<td>89</td>
<td>11</td>
<td>49</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Crasborn et al. (2008)</td>
<td>47</td>
<td>53</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Bank (2015)</td>
<td>85</td>
<td>15</td>
<td>61</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bank et al. (2015)</td>
<td>74</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Crasborn et al. (2008)</td>
<td>68</td>
<td>32</td>
<td>51</td>
<td>24</td>
</tr>
</tbody>
</table>

2 Research Questions and Hypotheses

Our first research question asks: What is the correlation between the rate of mouthing and the morphological complexity of the corresponding manual sign? As discussed above, previous research in many sign languages has indicated that there is an inverse relationship between these factors but this study is the first to investigate this using the BSL Corpus. Our study focuses on verbs, and of these, plain verbs are considered the most morphologically simple. Therefore our hypothesis is that the rate of mouthing on plain verbs is higher than on non-plain verbs.

In terms of social factors, we take the work of Rentelis (2011) as a starting point. Because he observed significant variation in the rate of mouthings on BSL verbs but not on nouns, this project just considers verbs. Rentelis analysed 250 verbs produced by participants in each of London and Glasgow. In the current study, we extend this to include individuals from Bristol as well as London in the south of the UK, and Belfast as well as Glasgow in the north. This provides a more varied sample in terms of region, with two regions in the southern part of the UK and two regions in the north. Additionally, our sample size overall is three-and-a-half times larger. Our research questions examine the effect of region, gender, age and language background on the rate of mouthing.

5 W-type mouth gestures are excluded from this study (see Section 3.2.2), so they are generally not included in this table. However, Bank (2015) does not distinguish them from other types of mouth gesture, so they are included in this row under ‘Mouth gesture’.

6 Swedish Sign Language.
mouthings produced with verbs. We expect to find, as Rentelis (2011) did, a lower rate of mouthing accompanying verbs in signers from the north of the UK as compared to those from the south. Similarly, in common with Rentelis’s findings, we expect to find that women produce more mouthings on verb signs than men.

Previous studies into the relationship between age and rate of mouthing in BSL have obtained mixed results; Sutton-Spence and Day (2001) found a correlation whereas Rentelis (2011) did not. We hypothesise that people aged 36-50 years at the time of corpus data collection use more mouthings than those of other age groups. This is because these individuals were likely to have been educated in a mainstream environment, with fewer deaf peers at school. This would entail reduced BSL input; instead they would have likely interacted with a Communication Support Worker using Sign-Supported English (SSE). Therefore English will have exerted a greater influence upon their signing, and they will use more mouthings accompanying verbs than the rest of the population. In contrast, signers in all the other age groups experienced mixed influences upon their mouthing, some factors serving to increase it and some to decrease it. Signers in the two oldest age groups in the corpus (aged 51 and over) were generally educated orally in residential schools for the deaf. The oral education might tend to increase their rate of mouthing whereas their centralised education promoted the use of BSL informally, which may have reduced their mouthing. The youngest signers (aged 16-35 years) mostly attended mainstream schools, which might tend to increase mouthing because of their contact with hearing class-mates, but the use of BSL in the classroom might reduce the influence of English and therefore reduce their mouthing.

No effect of language background has been found in previous studies of mouth activity. Therefore, we predict that there will be no difference between the rate of mouthing accompanying verbs produced by signers who grew up with and without deaf relatives.

3 Method

3.1 Data

The BSL Corpus (Schembri et al., 2013) formed the key data source for this project. During
its development, participants were chosen using non-random quota-based techniques with the aim of matching the proportions of age, gender, language background, region and ethnicity in the overall deaf community in the UK. All participants were deaf, and 95% said that they had been signing since at least the age of seven, with the remainder learning before age twelve. Participants were selected to match the changes in education policy in the UK described in Section 1.3.3.3, with approximately equal numbers of people recruited in each of the following age brackets: 65 years and older, 51 to 64 years, 36 to 50 years and 35 years and younger. They were filmed in pairs performing a variety of linguistic tasks including recounting a personal narrative and engaging in free conversation.

We selected a subset of corpus participants for the current study; as we wished to compare mouth activity between the north and the south of the UK, we examined 25 individuals from each of Glasgow and Belfast, representing the north, and 25 from each of Bristol and London, representing the south. Previous projects had already annotated certain parts of the corpus, and we used this as a starting point. In Bristol and London, only data from the conversation task had been annotated, whereas in Glasgow and Belfast, this was only the case for the narrative data. As discussed in Section 1.3.1, text-type can affect the rate of mouth activity so we considered carefully whether this data selection would provide a meaningful way to examine regional differences. As noted in Brown & Cormier (2017), there is overlap between the two text-types in our corpus, in that conversation naturally consists of elements of narrative, and conversely, our narratives are often punctuated by interjections by the co-participant. Therefore, we concluded that this data selection would be appropriate for this study.

We considered variation based on the social factors taken into account during BSL Corpus creation. However, we excluded ethnicity because there were too few non-white individuals (four Asian, four Black, one Other) amongst the subset of participants chosen. Statistically sound conclusions cannot be drawn from a sample with such little variation. Also, we were unable to analyse social class as this cannot be dissociated from participants’ age because of the differing
opportunities available to deaf people during the twentieth century as a result of changes in discrimination legislation and deaf education policy (Schembri et al., 2013). Details of the distribution of participants according to the social factors under consideration is shown in Table 2.

<table>
<thead>
<tr>
<th>Region</th>
<th>Gender</th>
<th>Age</th>
<th>Language Background</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>16-35</td>
<td>36-50</td>
</tr>
<tr>
<td>Belfast</td>
<td>13</td>
<td>12</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Bristol</td>
<td>13</td>
<td>12</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Glasgow</td>
<td>13</td>
<td>12</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>London</td>
<td>12</td>
<td>13</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>49</td>
<td>25</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 2: Distribution of participants by region, gender, age and language background

3.2 Coding Scheme

We examined the first (roughly) one hundred sign tokens produced on the dominant hand of each of the one hundred participants, to determine whether each was a verb. We tagged the mouth activity for those identified as verbs and recorded whether they were a plain or a non-plain verb. Similarly, we tagged any tokens made using the participant’s non-dominant hand. This approach means that it is not the case that the same number of verbs were identified for each participant, because they varied in the number of verbs produced during their first one hundred tokens.

As this study focused on lexicalised plain and indicating verbs, we excluded tokens of constructed action, gesture, depicting signs, points and fingerspelled items (glossed with a prefix of CA:, G:, DS:, PT: and FS: respectively as defined in Cormier, Fenlon, Gulamani, and Smith, 2015). False starts, plus tokens containing / or ?, indicating uncertainty about the correct annotation, were also excluded.

3.2.1 Identification of Verbs

As this project was to investigate the rate of mouthing on verbs, it was necessary to identify all the tokens of verbs in our subset of the corpus. This had already been done for the London and Bristol data for a different project (Fenlon, Schembri, & Cormier, 2018). However this was not the case for Glasgow and Belfast so we undertook this task as part of the current study.
As discussed in Nadolske and Rosenstock (2007), determining the grammatical class of a sign in any sign language is not straightforward. This is because many signs can take more than one grammatical role and this is not necessarily reflected in the morphology of the sign. Additionally, the sequence of the signs in an utterance is not a reliable indicator because sign languages generally have a relatively free constituent order (Johnston, Cresdee, Schembri, & Woll, 2015). Furthermore, the role of a particular token cannot be directly inferred based on its ID gloss (Johnston, 2012). Therefore we adopted a statistical approach, using the frequency with which a particular ID gloss had been identified as a verb in the parts of the corpus that were already tagged for grammatical category (as part of annotation for the study reported in Fenlon et al. (2018) as a starting point. We then made a judgement as to whether this categorisation was appropriate for each token in context. Signs such as DISAPPOINT and HAPPY posed a particular problem because it can be argued that they function either as adjectives or verbs in phrases such as PT-PRO1 DISAPPOINT (‘I was disappointed’). These tokens (40 in total) were therefore excluded from the study. In total 1874 verb tokens were identified.

We tagged each token identified as a verb as to whether it was ‘plain’ (body-anchored and not capable of modification) or ‘non-plain’. So, for example, we identified LOOK as non-plain because it is not body-anchored and it can be modified spatially towards its object. Similarly, GIVE-UP is non-plain, because it is not body-anchored. In contrast, THINK is a plain verb because it is body-anchored (at the forehead) and cannot be modified spatially.

### 3.2.2 Categorisation of Mouth Activity

We tagged each token identified as a verb in the parts of the corpus under consideration as having a ‘Mouthing’ if all or part of an English word was produced during that sign. We annotated signs as having a ‘Mouth Gesture’ if the mouth activity fitted the categorisation in Section 1.1, although following Crasborn et al. (2008), we excluded W-type. This is because they relate to the

7 This matched the existing coding of grammatical category in London and Bristol, where such tokens were not generally tagged as verbs.
whole face rather than to the mouth specifically and because they generally relate to emotion, which Boyes Braem and Sutton-Spence (2001) suggest should be treated separately. Where the mouth activity did not fall into one of the above categories, it was tagged as ‘none’. Where there was doubt as to the categorisation of tokens of mouth activity, we consulted a native signer, to maximise our accuracy.

For mouthings, following Sutton-Spence and Day (2001) and Nadolske and Rosenstock (2007), we did not make a distinction as to whether a full English word or a reduced form of that word is produced. This was not a focus of the current project, and we felt that, in any case, it is not possible to determine the full extent of mouth activity by considering only the visible articulators. For alternative approaches, see Johnston et al. (2016) and Bank et al. (2011).

In terms of temporal alignment, a given instance of mouth activity does not necessarily correspond exactly with a single manual sign. Some studies such as Crasborn et al. (2008), have documented the exact onset and offset times of mouth activity but since the present project focused only on the mouth activity associated with verbs, we recorded the mouth activity corresponding to each such sign. We coded the mouth activity that occurred with at least 50% of the manual sign, following Johnston et al. (2016); in most cases, the context indicated that this corresponded to the manual sign in question but occasionally, it related to the preceding or following sign. Where mouth activity did not relate specifically to verbs but to the signs preceding or following them (which happened with 49 tokens), it was excluded from further analysis.

Finally, we excluded four tokens whose mouth activity was indecipherable because the participant’s mouth was not clearly visible on the video recording. This left 1781 verb tokens to be analysed for mouth activity. We conducted a consistency check, with an independent annotator (hearing, fluent BSL signer with sign linguistics training) examining a random 20% sample of annotations. We obtained a Cohen’s kappa chance-corrected agreement index (Cohen, 1960) of 0.818, indicating very good agreement between the annotations of each coder.
3.3 Statistical Analysis

We employed variable rule analysis (Labov, 1969) to investigate the effect of each of the sociolinguistic factors under consideration on the mouth activity produced by participants. We conducted logistic regression and mixed-effects modelling using Rbrul (Johnson, 2009) to compute log odds which define the contribution that each factor makes to the model. We centred participants’ age around its mean to avoid tolerance issues, following Brown & Cormier (2017), and in each model, we included participant ID as a random effect. This accounts for the fact that some individuals in the study may produce, for example, more mouthing than their social factor attributes would predict. These social factors are then only deemed significant if their effect is large enough to rise above the individual variation, meaning that this method reduces the chance of type I errors (Johnson, 2009).

4 Results

4.1 Descriptive Statistics

4.1.1 Single Factors

Figures 1-5 show the relative proportion of mouth activity on verbs, overall and then split by each of the factors under consideration in turn. Each graph shows the extent of mouthing, mouth gesture and ‘none’ (i.e. no/other mouth activity) within the range indicated by the whiskers, with extent of mouth activity of the central 50% of participants shown in the boxes. Outliers are shown as dots on the graphs but are excluded from all descriptions of results in Section 4.1.8. For each social and linguistic factor below, we report results of chi-squared analyses using a threshold significance level of p=0.05.

Figure 1 shows the overall rate of mouth activity across all participants studied. Mouthing ranged from 35-94% while mouth gestures ranged from 0-47%. ‘None’ (no or other mouth activity) ranged from 0-46%.

8 Outliers are defined as data points which lie outside 1.5 times the interquartile range.
4.1.1 Linguistic Factor

4.1.1.1 Morphological Complexity

We found a significant difference in mouth activity between plain and non-plain verbs as shown in Figure 2 ($\chi^2 = 39.412$, df=2, p<0.001, Cramer’s V=0.149, which indicates a small to medium effect size). As shown in figure 2, for non-plain verbs, mouthing ranged from 13-100% while mouth gestures ranged from 0-50%. ‘None’ (no or other mouth activity) ranged from 0-55%. For plain verbs, mouthing ranged from 0-100% while mouth gestures ranged from 0-50%. ‘None’ (no or other mouth activity) ranged from 0-40%.
Figure 2: Percentage of mouth activity co-occurring with verbs, split by type of verb (plain vs. non-plain). Difference between plain and non-plain verbs is significant.

### 4.1.1.2 Social Factors

#### 4.1.1.2.1 Region

Figure 3 shows mouth activity split into the four regions investigated. A chi-squared analysis revealed that there is a significant difference in the rate of mouth activity between regions ($\chi^2 = 19.642$, df=6, $p=0.003$, Cramer’s V=0.074, which indicates a small effect size). In Belfast, mouthing ranged from 21-100% while mouth gestures ranged from 0-50%. ‘None’ (no or other mouth activity) ranged from 0-46%. In Bristol, mouthing ranged from 25-100%, mouth gestures from 0-39% and ‘none’ (no or other mouth activity) from 0-50%. In Glasgow, mouthing ranged from 22-94%, mouth gestures from 0-56% and ‘none’ (no or other mouth activity) from 0-42%. Finally, in London, mouthing ranged from 50-82%, mouth gestures from 0-33% and ‘none’ (no or other mouth activity) from 0-33%.
Figure 3: Percentage of mouth activity co-occurring with verbs, split by region (city). Difference between regions is significant.

If the data are combined for Belfast and Glasgow to represent the north of the UK, then comparing to the south of the UK (combining London and Bristol), the difference in mouth activity is more marked, as shown in Figure 4. The chi-squared statistic is also significant: $\chi^2 = 15.172$, df=2, $p=0.001$, Cramer’s V=0.092, which still indicates a small effect size. In the north of the UK, mouthing ranged from 21-100%, mouth gestures from 0-56% and ‘none’ (no or other mouth activity) from 0-55%. In the south, mouthing ranged from 50-100%, mouth gestures from 0-39% and ‘none’ (no or other mouth activity) from 0-38%.

Figure 4: Percentage of mouth activity co-occurring with verbs, split by region (north/south). Difference between regions is significant.
4.1.1.2.2 Gender

We found a significant difference in mouth activity between males and females in the study, as shown in Figure 5. ($\chi^2 = 8.446$, df=2, $p=0.015$, Cramer’s $V=0.069$, which indicates a small effect size.) In males, mouthing ranged from 21-100%, mouth gestures from 0-33% and ‘none’ (no or other mouth activity) from 0-55%. In females, mouthing ranged from 42-94%, mouth gestures from 0-39% and ‘none’ (no or other mouth activity) from 0-42%.

![Figure 5: Percentage of mouth activity co-occurring with verbs, split by gender. Difference between males and females is significant.](image)

4.1.1.2.3 Age

We investigated the mouth activity split by age group. A chi-squared analysis reveals that there is no significant difference between the groups ($\chi^2 = 10.072$, df=6, $p=0.122$ n.s., Cramer’s $V=0.053$, which indicates a small effect size). In participants aged between 16 and 35, mouthing ranged from 23-100%, mouth gestures from 6-33% and no/other mouth activity from 0-55%. For those aged between 36 and 50, mouthing ranged from 35-94%, mouth gestures from 0-25% and no/other mouth activity from 4-40%. People in the age range 51-64 produced mouthings 40-100% of the time, mouth gestures 0-50% of the time and no/other mouth activity also 0-50% of the time. Finally those aged 65 and older produced mouthings 42-94% of the time, mouth gestures 0-39% of the time and no/other mouth activity 0-42% of the time.
4.1.1.2.4 Language Background

There is no significant difference between the mouth activity produced by people with and without deaf relatives: $\chi^2 = 5.013$, df=2, p=0.082 n.s., Cramer’s V=0.053, which indicates a small effect size. In those with deaf relatives, mouthing ranged from 27-100%, and both mouth gestures and no/other mouth activity ranged from 0-50%. In those who reported no deaf relatives, mouthing ranged from 37-94%, mouth gestures ranged from 0-56% and no/other mouth activity ranged from 0-42%.

4.1.2 Variation in Mouth Activity by Participant

Figure 6 shows the variation in mouth activity between participants, ranked by increasing rate of mouthing. It shows that there is a great deal of variation, from a minimum of 10% mouthing to a maximum of 100%.

4.1.3 Variation in Mouth Activity by Sign

Figure 7 provides a breakdown of the mouth activity on each verb in our sample that occurs at least ten times. Where these were mouthings, the mouthings may be of all or part of any English translation equivalent of each verb, and not necessarily mouthing of the ID gloss shown. It is clear that there is little homogeneity in the choice of mouthing, mouth gesture or ‘none’ (no/other mouth activity) for a given sign.

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9 We excluded signs that occurred less than ten times in order to reduce the bias caused by a low frequency of occurrence.
Figure 6: Percentage of mouth activity co-occurring with verbs, for each participant. Number of tokens per participant shown in brackets.

![Figure 7: Breakdown of mouth activity associated with verbs occurring at least 10 times. Sorted by percentage of mouthing. Number of tokens per sign shown in brackets.](chart)

<table>
<thead>
<tr>
<th>Verb (number of tokens)</th>
<th>Percentage Mouth Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISCUSS (n=16)</td>
<td></td>
</tr>
<tr>
<td>DRIVE (n=15)</td>
<td></td>
</tr>
<tr>
<td>GO-TO (n=44)</td>
<td></td>
</tr>
<tr>
<td>FLOCK (n=16)</td>
<td></td>
</tr>
<tr>
<td>TOUCH (n=10)</td>
<td></td>
</tr>
<tr>
<td>LOOK02 (n=54)</td>
<td></td>
</tr>
<tr>
<td>INVOLVE (n=14)</td>
<td></td>
</tr>
<tr>
<td>SIGN (n=34)</td>
<td></td>
</tr>
<tr>
<td>REDUCE (n=17)</td>
<td></td>
</tr>
<tr>
<td>FROM-TO (n=31)</td>
<td></td>
</tr>
<tr>
<td>WALK (n=15)</td>
<td></td>
</tr>
<tr>
<td>EXPLAIN (n=11)</td>
<td></td>
</tr>
<tr>
<td>MEET (n=19)</td>
<td></td>
</tr>
<tr>
<td>ARRIVE (n=22)</td>
<td></td>
</tr>
<tr>
<td>LOOK (n=45)</td>
<td></td>
</tr>
<tr>
<td>GIVE (n=12)</td>
<td></td>
</tr>
<tr>
<td>GO02 (n=10)</td>
<td></td>
</tr>
<tr>
<td>HAPPEN (n=10)</td>
<td></td>
</tr>
<tr>
<td>THINK (n=61)</td>
<td></td>
</tr>
<tr>
<td>RUN (n=11)</td>
<td></td>
</tr>
<tr>
<td>CHANGE (n=10)</td>
<td></td>
</tr>
<tr>
<td>GO (n=36)</td>
<td></td>
</tr>
<tr>
<td>TALK (n=16)</td>
<td></td>
</tr>
<tr>
<td>MOVE (n=17)</td>
<td></td>
</tr>
<tr>
<td>WANT (n=55)</td>
<td></td>
</tr>
<tr>
<td>KNOW (n=45)</td>
<td></td>
</tr>
<tr>
<td>WAIT (n=10)</td>
<td></td>
</tr>
<tr>
<td>START (n=23)</td>
<td></td>
</tr>
<tr>
<td>TEACH (n=13)</td>
<td></td>
</tr>
<tr>
<td>PUSH (n=14)</td>
<td></td>
</tr>
</tbody>
</table>

---
4.2 Correlation Between Individual Factors and Mouthing

We conducted logistic regression with a significance threshold of 0.05, to determine the correlation with mouthing of each linguistic and social factor individually. We report log odds; those that are positive indicate that the corresponding factor favours mouthing. These have a centred factor weight greater than 0.5. Conversely, negative log odds and a centred factor weight less than 0.5 mean that the factor disfavours mouthing.

4.2.1 Linguistic Factor

Our linguistic factor, whether each verb was plain or non-plain, was a significant predictor of the use of mouthing, as shown in Table 3. Plain verbs significantly favour mouthing whereas non-plain verbs disfavour mouthing (p<0.01).

<table>
<thead>
<tr>
<th>Verb type</th>
<th>Log odds</th>
<th>Tokens</th>
<th>Mouthing/All</th>
<th>Centred factor weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain verb</td>
<td>0.387</td>
<td>465</td>
<td>0.757</td>
<td>0.596</td>
</tr>
<tr>
<td>Non-Plain Verb</td>
<td>-0.387</td>
<td>1316</td>
<td>0.595</td>
<td>0.404</td>
</tr>
</tbody>
</table>

Table 3: Logistic regression analysis of effect of verb type on rate of mouthing; log odds and centred factor weights. Application value: presence of mouthing.

4.2.2 Social Factors

Turning to our social factors, the most significant is region (p=0.034). As the data in Table 4 shows, Bristol favours mouthing and London slightly favours it whereas Belfast and Glasgow both disfavour the feature.

<table>
<thead>
<tr>
<th>Region</th>
<th>Log odds</th>
<th>Tokens</th>
<th>Mouthing/All</th>
<th>Centred factor weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bristol</td>
<td>0.360</td>
<td>432</td>
<td>0.706</td>
<td>0.589</td>
</tr>
<tr>
<td>London</td>
<td>0.036</td>
<td>494</td>
<td>0.656</td>
<td>0.509</td>
</tr>
<tr>
<td>Belfast</td>
<td>-0.194</td>
<td>414</td>
<td>0.592</td>
<td>0.452</td>
</tr>
<tr>
<td>Glasgow</td>
<td>-0.202</td>
<td>441</td>
<td>0.592</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Table 4: Logistic regression analysis of effect of region on rate of mouthing; log odds and centred factor weights. Application value: presence of mouthing.

Gender also significantly correlates with mouthing (p=0.0434), with women somewhat favouring mouthing and men somewhat disfavouring it, as shown in Table 5.
4.3 Analysis Using Multivariate Logistic Regression

We examined the effect of all the social factors under consideration on the rate of mouthing. This revealed that only gender (p=0.0414) reached significance (alpha = 0.05), with women slightly favouring mouthing and men slightly disfavouring it. The remaining factors region, age, and language background were not significant when combined in this way. See Tables 6-9.

<table>
<thead>
<tr>
<th>Region</th>
<th>Log odds</th>
<th>Tokens</th>
<th>Mouthing/All</th>
<th>Centred factor weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bristol</td>
<td>0.346</td>
<td>432</td>
<td>0.706</td>
<td>0.586</td>
</tr>
<tr>
<td>London</td>
<td>0.050</td>
<td>494</td>
<td>0.656</td>
<td>0.513</td>
</tr>
<tr>
<td>Belfast</td>
<td>-0.181</td>
<td>414</td>
<td>0.592</td>
<td>0.455</td>
</tr>
<tr>
<td>Glasgow</td>
<td>-0.215</td>
<td>441</td>
<td>0.592</td>
<td>0.446</td>
</tr>
</tbody>
</table>

Table 6: Logistic regression analysis of effect of all social factors on rate of mouthing; log odds and centred factor weights for region. Application value: presence of mouthing.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Log odds</th>
<th>Tokens</th>
<th>Mouthing/All</th>
<th>Centred factor weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.149</td>
<td>964</td>
<td>0.667</td>
<td>0.537</td>
</tr>
<tr>
<td>Male</td>
<td>-0.149</td>
<td>817</td>
<td>0.602</td>
<td>0.463</td>
</tr>
</tbody>
</table>

Table 7: Logistic regression analysis of effect of all social factors on rate of mouthing; log odds and centred factor weights for gender.

<table>
<thead>
<tr>
<th>Language Background</th>
<th>Log odds</th>
<th>Tokens</th>
<th>Mouthing/All</th>
<th>Centred factor weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing</td>
<td>0.029</td>
<td>1055</td>
<td>0.628</td>
<td>0.507</td>
</tr>
<tr>
<td>Deaf</td>
<td>-0.029</td>
<td>726</td>
<td>0.650</td>
<td>0.493</td>
</tr>
</tbody>
</table>

Table 8: Logistic regression analysis of effect of all social factors on rate of mouthing; log odds and centred factor weights for language background.

<table>
<thead>
<tr>
<th>Age (continuous)</th>
<th>Log odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>+1</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Table 9: Logistic regression analysis of effect of all social factors on rate of mouthing; log odds for age (continuous).
4.4 Individual Variation and the Regression Models

The total variance in mouthing explained by each of our models ($R^2$) ranged from only 8.8% to 11.3%. Additionally, the estimated standard deviation of our random factor (participant) is large in all our models, varying between 0.481 and 0.551. Both these statistics indicate that there is a large amount of variation between individuals in our study.

5 Discussion

Overall, we found a strong association between verb type and rate of mouthing, with mouthing produced significantly more with plain than non-plain verbs. When considering each social factor in isolation, we found that only region and gender were significant, with individuals in the south of the UK producing more mouthings with verbs than those in the north. Only gender reached significance as a predictor when combined with the other social factors. We now discuss how these results relate to our hypotheses and to previous studies.

5.1 Morphological Complexity

Looking first at our linguistic factor, our hypothesis that the rate of mouthing is inversely proportional to the morphological complexity of the accompanying verb sign was upheld. Verb type is a highly significant predictor, with a markedly larger amount of mouthing observed on plain verbs (76%) compared to non-plain verbs (59%). This supports general findings from previous studies covering a range of sign languages, as discussed in Section 1.3.2.

However, looking at studies that quote specific figures for mouth activity on plain and non-plain verbs, we see some differences. Auslan and BSL are very closely related languages; in fact Johnston (2001) argues that they are dialects of the same language. Therefore we may expect similar results in our study compared to Johnston et al. (2016), yet their findings are very different, as shown in Tables 10 and 11.
For both plain and non-plain verbs, our study found a far higher proportion of mouthings and a far lower proportion of mouth gestures. This may be explained by the fact that the overall Auslan Corpus, upon which their study was based, contains a large amount of narrative-retelling rather than personal narratives. As discussed in Section 1.3.1, narrative retellings are likely to contain more constructed action (and therefore mouth gesture) than conversation. Since Johnston et al. do not report what proportion of the subset of their corpus is narrative retelling, we cannot be sure of the size of this effect.

### 5.2 Region and Gender

Turning now to social factors, our hypothesis relating to region is supported by our findings; the rate of mouthing in the north of the UK (59%) is significantly lower than in the south (68%).

This is driven by the fact that participants from Bristol produced fewer mouth gestures than those in the rest of the country; mouth gestures made up 14% of Bristol participants’ mouth activity as compared with 21% for Belfast. However, because the project compared conversation data in the south with personal narrative data in the north, further research is required to establish whether it is the regional difference or the text type difference that is correlated with the observed effect. The results of Rentelis (2011) are supported by this work. Rentelis looked at conversation data from both the north and south of the UK, but our study considered nearly twice as many tokens.

A significant effect of gender was observed, supporting our hypothesis. The rate of
mouthing amongst males (60%) was significantly lower than that amongst females (67%). This confirms the effect that Rentelis (2011) found with his smaller data sample. As discussed by Rentelis and by Ladd (2003), the greater use of mouthings by women may be because the use of mouthings with BSL is considered to have higher prestige, and women are known to adopt prestige language forms ahead of men. Ladd identifies working-class and middle-class groups within the British deaf community and suggests that middle-class deaf people aspire to speaking rather than signing when in the company of hearing people. Since mouthings in BSL are influences of spoken English, signing with mouthing could be said to be a prestige variety of BSL. The fact that Labov (2001) claims that women adopt prestige forms ahead of men might therefore explain why women use mouthings more than men.

5.3 Age and Language Background

We had expected to find that signers aged 36-50 would use significantly more mouthings than the other participants, because of the greater use of spoken English during their education. But this was not the case; the rate of mouthing amongst these participants (64%) was almost identical to the rate in all the other age groups (63%). However, we hypothesised that whether a participant had deaf family members would not affect their rate of mouthing with verbs, and this was supported by the data. The rate of mouthings amongst people with at least one deaf relative (65%) is not significantly different to those with only hearing family members (63%). It is possible that the influence of the surrounding spoken language on mouthing with BSL is so strong that no additional effect of age or language background can be observed. Additionally, according to the apparent time hypothesis (Bailey, Wikle, Tillery, & Sand, 1991), the lack of difference between age groups suggests that the rate of mouthing has not been changing in BSL, despite the changes in deaf education policy over the last century.

5.4 Individual variation

Our regression statistics indicate that the explanatory power of the social factors is small and there is a great deal of variation between participants in the proportions of mouthing that they
produce. Figure 10 illustrates the degree of variability between individuals. Similar effects have been found in other studies; for example, Nadolske and Rosenstock (2007) found in their study of ASL story-telling that the rate of mouthing across only seven retellings ranged from below 30% to 60%.

The amount of individual variation was also reported in Johnston et al. (2016). Although their data covers all grammatical categories and four sign languages (Auslan, BSL, NGT and SSL), whereas the present study considers only verbs in BSL, a remarkably similar pattern and degree of variation is observed in comparison to the current study. This is despite the fact that the Auslan data in their study amounted to over 17 000 tokens, nearly ten times larger than was possible in the current project (1781). They also included fewer participants; 38 rather than 100; the larger number of tokens per participant in the Auslan study means that the mouth activity distribution for each individual is less prone to sampling error. The fact that we studied mouthing in fewer tokens per participant but in more individuals, and still found a similar amount of individual variation as the Auslan study, strengthens this overall finding across the studies.

In terms of variation per sign, it is clear from Figure 11 that there is generally no standard choice of mouthing, mouth gesture or ‘none’ (no/other mouth activity) per verb, as was observed by Bank et al. (2011). This, and the high degree of variation in mouth activity per participant, clearly shows that mouthings on verbs in BSL are not compulsory. This leads us to the conclusion that participants are (sub-consciously) choosing in real-time what mouth activity to combine with each manual sign, and that where they choose mouthing, this constitutes code-blending between English and BSL.

5.5 Overall Rate of Mouth Activity

Table 12 summarises the overall rate of mouth activity in this study. Although this study covered only mouth activity with verbs, its findings are broadly consistent with past research covering a range of sign languages on rate of mouthing (cf. Table 1).

Considering the BSL data specifically, the most striking observation is the high degree of
similarity between the current study and that of Sutton-Spence and Day (2001). This is even though the earlier work considers all grammatical categories of sign rather than just verbs, and despite the fact that it covers many different text types. It may be that individual variation has been evened-out because both studies used a relatively large number of participants (39 for Sutton-Spence and Day, 100 for the current study).

In contrast, the BSL participants from Crasborn et al. (2008) produced mouthings at about half the rate that we observed. This may be due to the lower rate of mouthing generally associated with narrative retelling since Crasborn et al. used a story-telling task whereas our study involved free conversation and personal narratives. The difference may be more pronounced because Crasborn et al.’s participants were experienced storytellers (cf. Earis & Cormier, 2013) so they may have used more mouth gestures in their dramatic portrayal, whereas the BSL Corpus participants had no particular skill in story-telling. Additionally, the BSL Corpus data was collected in a way that encouraged production of ‘vernacular BSL’ (Schembri et al., 2013), which involves some English code mixing (including mouthing of words derived from English). Crasborn et al.’s participants may have used a more ‘self-conscious’ style of BSL, including ‘hypercorrection’ (Schembri et al., 2013) to reduce English influence, perhaps because they knew that their production was to be archived as examples of high-quality BSL storytelling.

<table>
<thead>
<tr>
<th>% mouth activity overall</th>
<th>% of mouth activity w/manual signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouthing</td>
<td>Mouth gesture</td>
</tr>
<tr>
<td>77</td>
<td>23</td>
</tr>
</tbody>
</table>

Table 12: Summary of mouth activity with BSL verbs in current study.

5.6 Future Research

This study focussed primarily on mouthing with BSL verbs; future studies could also consider the distribution of mouthing, mouth gestures and no/other mouth activity in BSL generally. We compared mouth activity used in conversation data for the south of the UK to narrative data from the north, so further research using a single text type from the BSL Corpus would establish whether the regional difference in mouthing we observed is due to this text type difference or due to
a genuine geographic variation.

Future studies of mouthing in BSL could investigate which English words (or which parts of words) are mouthed with particular signs, or the extent to which the same temporal reductions in a given mouthing are used across sign tokens and across signers. The effect of sign frequency on mouth activity could also be explored. Additionally, future studies could consider the temporal alignment of mouthings with the manual component of the sign. A high degree of variation in these areas would provide stronger evidence that mouthing is an example of code-blending between the sign language and the matrix spoken language, because it would suggest that the signer has more freedom over which mouthing (if any), and how much of it, to produce with a manual sign, as discussed in Bank et al. (2011). (Bank et al., 2011)

In addition to mouthing, the use of fingerspelling is another influence from the surrounding spoken language upon sign language. Mouthings and fingerspellings are inter-linked, in that mouthings can be used to disambiguate fingerspelling sequences (Brown & Cormier, 2017). It was not possible to work directly with the survey of fingerspelling carried out by Brown and Cormier because the present study concentrated on lexical verbs and so excluded non-lexicalised fingerspelling. In terms of future research, one could investigate, for example, the percentage of mouthings that occur with fingerspellings, and conversely, the percentage of fingerspellings that are mouthed.

5.7 Conclusion

Our study examined extracts from the BSL Corpus to determine the effect of various sociolinguistic factors on the rate of mouthing accompanying verb signs in BSL. In terms of linguistic factors, our hypothesis was that mouthing occurs more frequently with plain verbs than with indicating or depicting verbs, and this was strongly supported. We suggest that this is because the translation equivalent of a given non-plain verb is often a phrase (rather than a single word), which cannot be incorporated in a single mouthing. Therefore, mouth gestures are more likely to accompany such morphologically complex verbs. Although this has previously been observed in
BSL using a range of smaller datasets, and in Auslan using a corpus consisting mainly of narrative re-tellings, this is the first time that such research has been undertaken using a corpus of spontaneous sign language data.

The social factors that we considered were region, gender, age and language background. We used a larger sample size than was possible in the key previous study using the BSL Corpus, Rentelis (2011), and our findings back-up and extend this research. We concluded that mouthings are used significantly more by signers in the south of the UK (London and Bristol) compared with those in the north (Glasgow and Belfast), although we note that further research is needed to establish whether this is a genuine regional difference.

We also found a significant gender difference; women produce more mouthings with verbs than men. This may be because use of mouthings is associated with a higher prestige form of BSL, and the fact that women tend to adopt prestige forms ahead of men. We did not find any effect of age on the observed rate of mouthing accompanying verbs, suggesting that the changes in education of deaf children during the twentieth century have not had an effect on this. Similarly, we found no effect of language background.

Overall, our sociolinguistic factors only explained around ten percent of the observed variation, implying that other factors are contributing to this. Furthermore, we observed a high degree of variation between participants in the rate of mouthing production alongside verbs, and a lack of consistency in the choice of mouth activity with a given verb. All this suggests that mouthings are unlikely to be an inherent compulsory part of the phonological or lexical specification of a sign; instead they are better considered as independent units that can be combined with the manual sign in the process of code-blending.

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