Research Report

The Face of Bimodal Bilingualism

Grammatical Markers in American Sign Language Are Produced When Bilinguals Speak to English Monolinguals

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ABSTRACT—*Bimodal bilinguals, fluent in a signed and a spoken language, provide unique insight into the nature of syntactic integration and language control. We investigated whether bimodal bilinguals who are conversing with English monolinguals produce American Sign Language (ASL) grammatical facial expressions to accompany parallel syntactic structures in spoken English. In ASL, raised eyebrows mark conditionals, and furrowed eyebrows mark* wh*-questions; the grammatical brow movement is synchronized with the manual onset of the clause. Bimodal bilinguals produced more ASL-appropriate facial expressions than did nonsigners and synchronized their expressions with the onset of the corresponding English clauses. This result provides evidence for a dual-language architecture in which grammatical information can be integrated up to the level of phonological implementation. Overall, participants produced more raised brows than furrowed brows, which can convey negative affect. Bimodal bilinguals suppressed but did not completely inhibit ASL facial grammar when it conflicted with conventional facial gestures. We conclude that morphosyntactic elements from two languages can be articulated simultaneously and that complete inhibition of the nonselected language is difficult.*

By studying bilinguals fluent in a signed and a spoken language (bimodal bilinguals), researchers can address fundamental questions about shared syntactic representations and language control. Because their two languages are produced by different articulators, bimodal bilinguals can produce elements from both of their languages simultaneously—an impossible feat for unimodal bilinguals (e.g., *cat* and *gato* cannot be produced at the same time; see Emmorey, Borinstein, Thompson, & Gollan, 2008). Studies of cross-linguistic priming indicate that syntactic representations may be integrated for bilinguals, but only if the form of the structure is similar in the two languages (Desmet & Declercq, 2006; Hartsuiker, Pickering, & Veltkamp, 2004; Loebell & Bock, 2003). We investigated whether bimodal bilinguals produce grammatical facial expressions from American Sign Language (ASL) while expressing parallel syntactic structures in English. Such a finding would indicate that distinct morphosyntactic elements from two languages can be integrated within a syntactic representation and that this integration can occur all the way to the level of articulation. Furthermore, we examined the strength of this syntactic integration and the degree of language control by investigating whether ASL grammatical facial expressions are produced even when bimodal bilinguals converse with nonsigning English speakers. Production of ASL grammatical expressions in monolingual situations would indicate that shared syntax makes language control and inhibition of the nonselected language difficult.

In ASL, raised eyebrows and a slight head tilt mark conditional clauses, and furrowed brows mark *wh*-clauses (questions introduced with a "wh" element, e.g., *who*, *what*, *where*; see Fig. 1; Baker & Cokely, 1980; Baker & Padden, 1978; Baker-Shenk, 1983; Liddell, 1980). Unlike affective or social facial expressions, grammatical facial expressions in ASL have a clear and sharp onset that co-occurs with the beginning of the relevant grammatical structure (Reilly, McIntire, & Bellugi, 1990). This use of facial expressions to mark syntactic structures is common across signed languages (e.g., Zeshan, 2004a, 2004b).

For nonsigning English speakers, these facial expressions convey affective and pragmatic, rather than syntactic, information. In conversational facial gesture, the raised eyebrows associated with conditional clauses in ASL convey positive affect (e.g., openness to interaction), whereas the furrowed brows associated with *wh*-clauses in ASL generally convey negative affect (e.g., anger, puzzlement; Ekman, 1979; Granström & House, 2005; Janzen & Shaffer, 2002; Krahmer & Swerts, 2005; Srinivasan & Massaro, 2003; Stern, 1977). We investigated

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Fig. 1. Illustration of grammatical facial expressions in American Sign Language (ASL). The illustration in (a) shows raised eyebrows produced at the onset of an ASL conditional clause. The speaker is signing, ''RAIN, CLASS CANCEL,'' which translates into English as ''If it rains, class will be canceled.'' The illustration in (b) shows furrowed brows produced at the onset of an ASL *wh*-question. The speaker is signing, ''HOW-MANY SIBLINGS HE/SHE HAVE,'' which translates into English as ''How many siblings does he/she have?''

whether the social and pragmatic functions of these facial expressions modulate the expression of ASL facial grammar when bimodal bilinguals converse with monolingual English speakers. We predicted that if they do, bimodal bilinguals would inhibit the production of *wh*-clause markers more than that of conditional markers, because of their differential association with negative and positive affect. The degree of such inhibition is an indicator of the amount of control that bilinguals can have over specific syntactic structures in the nonselected language.

Finally, we also explored whether native-English-speaking nonsigners produce ASL-like facial expressions under the same conditions. Data from nonsigners provide base-rate information about the production of ASL-like expressions within these syntactic contexts.

METHOD

Participants

Twelve hearing native ASL-English bilinguals (9 females and 3 males; mean age = 32.5 years, SD = 8.8) were recruited. All had Deaf signing families and rated themselves highly proficient in ASL (score of 6 or higher on a 7-point fluency scale), and all but 1 rated themselves highly proficient in English. Bimodal bilinguals' fluency ratings for ASL (M = 6.5, SD = 0.5) and English ($M = 6.7$, $SD = 0.6$) did not differ, $t(11) = 0.61$, $p = .56$, $p_{rep} = .457$, $d = 0.31$. These participants reported using ASL for 44% of their day, on average (SD = 20%). Eleven native-English-speaking nonsigners (8 females and 3 males) participated in the comparison group (mean age = 29.73 years, SD = 4.1). A 12th nonsigner with extensive theater training was excluded from the analysis. All participants had some college education.

Procedure

In the English condition, participants were told that we were examining the production of certain sentence types in English. Their task was to tell a listener (an English-speaking confederate naive to the goals of the study) concisely what they would do in six hypothetical situations. Participants reviewed the hypothetical situations in advance to prepare their responses. They were also instructed to obtain nine pieces of information from

their partner (e.g., hometown, date of last vacation); this procedure elicited the full array of *wh*-question words.[1] We told participants to ask the questions first, because this would help them get to know an unfamiliar conversation partner and put them at ease in the situation. Bimodal bilingual participants were told that their conversational partners did not know ASL.

The confederate sat to the right of a camera that filmed a close-up of the participant's face. During the interaction, the experimenter held cue cards in random order above the camera to inform the speaker which of the nine facts to elicit and then which of the six hypothetical scenarios they should discuss.

After completing the English condition, the bimodal bilinguals stayed to repeat the interview with a Deaf native-ASL-signing confederate ignorant of the aims of the study. They asked the same questions and discussed the same hypothetical situations as in the English condition. This ASL condition served as a baseline measure of consistency for production of the grammatical facial expressions in ASL. For this condition, a second camera framed the signer's head and torso to record his or her signs.

Coding

All targeted conditional sentences and *wh*-questions were transcribed into a FileMaker Pro database. Clause-onset time was recorded using a FileMaker Pro plug-in (AutoLog 5.0) that captured and stored the time code from the video (30 frames/s). Facial expressions that accompanied the participants' speech were coded for onset and type (raised or furrowed brow). Only facial expressions that accompanied unambiguous conditionals and *wh*-questions were included in the analysis. A subset of the data was coded by a rater who was blind to each participant's type (bimodal bilingual vs. nonsigner), so that we could determine reliability; agreement between the two raters was high (Cohen's $\kappa = .91$).

The onset of each facial expression, relative to its associated clause, was calculated by subtracting the time of clause onset from the time of expression onset. A negative value indicated that the expression began before the onset of the clause, whereas a positive value indicated that it began after the onset of the clause. To eliminate facial expressions that began while participants were reading the experimenter's prompts, we excluded expressions with relative onsets more than 2 standard deviations from the combined mean onset for the two sentence types, reducing the data set by about 10%.

RESULTS

The targeted response was not always elicited; sometimes a participant asked a yes/no question instead of a *wh*-question, or produced a statement instead of a hypothetical. In the English condition, bimodal bilinguals produced an average of 4.5 conditional clauses ($SD = 1.7$) and 7.5 *wh*-questions ($SD = 1.8$). Nonsigners produced an average of 5.2 conditional clauses ($SD = 1.2$) and 8.6 *wh*-questions ($SD = 0.7$). There was no difference between groups in the number of conditional clauses produced, $t(21) = 1.1, p = .28, p_{rep} = .66, d = 0.48$, or in the number of *wh*-questions produced, $t(21) = 1.9, p = .07, p_{rep} = .85, d = 0.82$. For each participant, we calculated the proportion of conditional clauses that were produced with a raised brow and the proportion of *wh*-questions that were produced with a furrowed brow (see Table 1). Arcsine transformations were performed before statistical analyses (results were the same with untransformed data). A 2 (group) × 2 (clause type) repeated measures analysis of variance (ANOVA) revealed that bimodal bilinguals produced more English clauses with ASL-appropriate facial expressions than did nonsigners, $F(1, 21) = 12.35, p = .002, p_{rep} = .98, \eta_p^2 = .37$. Both groups produced more ASL-appropriate facial expressions for conditional clauses than for *wh*-questions, $F(1, 21) = 18.57, p < .001, p_{rep} = .99, \eta_p^2 = .469$.[2] There was no interaction between group and clause type, $F < 1$.

TABLE 1
Mean Proportion of English and American Sign Language (ASL) Sentences Produced With ASL-Appropriate Facial Expressions

	Conditionals with raised brow		*Wh*-questions with furrowed brow	
Group and condition	*M*	*SD*	*M*	*SD*
Nonsigners	.48	.39	.05	.06
Bimodal bilinguals				
English condition	.79	.30	.37	.30
ASL condition	.97	.07	.85	.22

We conducted a *t* test assessing the difference between the two groups in the relative onset of conditional facial expressions. The onset of the raised brow was significantly closer to the onset of the spoken conditional clause for bimodal bilinguals ($M = 215$ ms, $SD = 308$ ms) than it was for nonsigners ($M = 785$ ms, $SD = 705$ ms), $t(17) = 2.4, p = .028, p_{rep} = .91, d = 1.17$. Data from the nonsigners were insufficient to allow a parallel analysis for the *wh*-questions.

We also compared the facial expressions produced by bimodal bilinguals while speaking English with the expressions they produced while signing ASL (see Table 1). We entered the proportion of clauses produced with their associated ASL facial expression into a 2 (language) × 2 (clause type) repeated measures ANOVA. Bimodal bilinguals produced significantly more ASL-appropriate facial expressions in ASL than in En-

[1]The elicitation materials for conditionals and *wh*-questions are included in supplementary materials available on-line (see p. 536).

[2]Video examples of a nonsigner producing raised brows with a conditional clause, a bimodal bilingual producing raised brows with a conditional clause, and a bimodal bilingual producing furrowed brows with a *wh*-question are included in the supplementary materials available on-line (see p. 536).

glish, $F(1, 11) = 21.1$, $p = .001$, $p_{rep} = .99$, $\eta_p^2 = .657$. They also produced significantly more ASL-appropriate expressions with conditionals than with *wh*-questions, $F(1, 11) = 13.03$, $p = .004$, $p_{rep} = .97$, $\eta_p^2 = .542$. There was no interaction between language and clause type, $F(1, 11) = 1.6$, $p = .23$, $p_{rep} = .7$, $\eta_p^2 = .13$. Planned comparisons indicated marginally greater production of raised eyebrows during ASL conditionals than during English conditionals, $t(11) = 2.16$, $p = .054$, $p_{rep} = .872$, $d = 0.92$, and significantly greater production of furrowed eyebrows during ASL than during English *wh*-questions, $t(11) = 4.03$, $p = .001$, $p_{rep} = .99$, $d = 1.59$. Finally, bimodal bilinguals produced fewer ASL-appropriate facial expressions with English *wh*-questions than they did with English conditionals, $t(11) = 3.07$, $p = .01$, $p_{rep} = .95$, $d = 1.85$.

DISCUSSION

The results provide clear evidence that bimodal bilinguals produce ASL facial grammar while speaking English. The fact that bimodal bilinguals timed the onset of their facial expressions with the onset of the relevant English syntactic structures indicates that they were producing linguistic, rather than affective, gestural facial expressions. Overt and simultaneous production of distinct morphosyntactic elements from two languages is evidence for a dual-language architecture in which grammatical information can be integrated and coordinated at all levels of processing, including phonological implementation. These results are less consistent with a separate-syntax account in which there are entirely separate syntactic representations for the two languages (see Hartsuiker et al., 2004). In all probability, syntactic integration is constrained by grammatical differences between languages, such that compatible structures (e.g., those studied here) are more likely to be integrated than structures with nonoverlapping form (e.g., different word order). In addition to syntactic compatibility, production compatibility may play a role. Specifically, the production of facial expressions is compatible in ASL and English because the expressions are produced simultaneously with manual signs in the former case and simultaneously with spoken words in the latter case.

Nonsigners raised their eyebrows about half of the time when producing English conditional clauses. Such frequent production of ASL-like facial expressions suggests that the ASL conditional marker may have its origin in cospeech facial gesture. Linguistic analyses have shown that other grammatical markers in ASL (e.g., markers for topicalization, referential shift, and negation) originate from the communicative gestures of the hearing community (Janzen & Shaffer, 2002; McClave, 2001; Zeshan, 2004a). The fact that nonsigners rarely produced furrowed brows during *wh*-questions does not necessarily indicate that this marker does not have a gestural origin because, in situations of true puzzlement, English speakers do furrow their brows when asking questions (Ekman, 1979). When facial gestures become grammaticized in ASL, they generalize to more contexts and become synchronized with their corresponding manual clauses. Because of the overlapping form of ASL grammatical markers and facial gestures, bimodal bilinguals must manage both the grammatical and the affective functions of their faces.

Our results suggest that inhibition of ASL facial grammar may be modulated by affective and pragmatic factors. Bimodal bilinguals produced raised eyebrows marking conditional clauses significantly more often than they produced furrowed brows marking *wh*-questions. For nonsigners, raised eyebrows signal openness and also mark prosodic prominence in an English utterance; speakers raise their eyebrows to emphasize the word or phrase they are producing (Granström & House, 2005). Thus, when bimodal bilinguals produce raised eyebrows with an English conditional, the raised brows could be interpreted as marking prominence over the entire clause, and therefore this facial expression would not be atypical for the conversational situation. In informal questioning with unfamiliar conversational partners, speakers also will typically raise their brows to signal an invitation to respond and openness to interaction (Janzen & Shaffer, 2002; Stern, 1977). In contrast, for this same situation, furrowed brows would signal anger, irritation, or true puzzlement (Ekman, 1979). We speculate that nonsigners might therefore interpret the furrowed-brow expressions produced by bimodal bilinguals as having a negative meaning, and we are currently testing this hypothesis. Bimodal bilinguals' differential production of the two brow movements (i.e., the fact that they furrow their brows less often when asking *wh*-questions than they raise their brows when producing conditionals) indicates that they contend with an articulatory conflict. Indeed, bimodal bilinguals may modulate and inhibit the expression of ASL facial grammar on the basis of information about the functions of conventional facial gesture. Bimodal bilinguals may be more likely to suppress ASL facial grammar when it conflicts with conventional facial gesture than when it does not.

An alternative explanation for the signers' differential production of raised and furrowed brows is that the conditional facial expression is produced more consistently than the *wh*-question facial expression in ASL (see Table 1). If this explanation is correct, the difference between the frequencies of the two facial expressions should be equal in ASL and English. However, the difference between the proportions of conditional and *wh*-questions paired with ASL facial expressions was only .12 in the ASL condition, compared with .42 in the English condition.

Under either explanation, our results suggest that articulatory inhibition of grammatical elements of the nonselected language is relatively difficult. Specifically, bimodal bilinguals did not completely inhibit the production of furrowed brows with English *wh*-questions, even when this facial gesture could communicate pragmatically inappropriate and misleading information. Indeed, bimodal bilinguals report that nonsigners frequently misinterpret their facial expressions as conveying negative affect, particularly when they ask questions (Preston, 1994).

Unimodal bilinguals have extensive practice with articulatory inhibition because they are forced to select a single language to produce. When unimodal bilinguals converse with other bilinguals, they often switch from one language to the other. In contrast, bimodal bilinguals rarely code-switch; rather, they consistently produce code blends in which sign and speech are produced simultaneously (Bishop, 2006; Emmorey et al., 2008). Hearing children acquiring a signed and a spoken language also show extensive and early production of code blends (Petitto et al., 2001; van den Bogaerde & Baker, 2006). Thus, bimodal bilinguals have less practice inhibiting the production of a nonselected language than unimodal bilinguals do. Bialystok and her colleagues have argued that practice with managing two language systems enhances general cognitive-control processes that are responsible for inhibition of information (for a review, see Bialystok, 2001). We hypothesize that if the key to enhancing cognitive-control processes in bilinguals is practice with articulatory inhibition, then bimodal bilinguals will not show the same enhancement because they do not have the same degree of practice.

The study of bimodal bilinguals allows researchers to isolate those aspects of bilingualism that arise from articulatory constraints and to illuminate those that are independent of language modality. The current study reveals that articulation of grammatical elements from a nonselected language is possible and that articulatory inhibition is difficult. Researchers' understanding of the nature of syntactic integration and language control can be enhanced by further investigations with this unique bilingual population.

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SUPPLEMENTARY MATERIAL

The following supplementary material is available for this article:
Elicitation Materials
Video 1: Bimodal Bilingual Producing Furrowed Brows With a *Wh*-question
Video 2: Bimodal Bilingual Producing Raised Brows With a Conditional
Video 3: Nonsigner Producing Irregularly Timed Raised Brows With a Conditional

This material is available as part of the on-line article from http://www.blackwell-synergy.com/doi/full/10.1111/j.1467-9280.2008.02119.x (this link will take you to the article's abstract).

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