Listener-adapted speech: bilinguals adapt in a more sensitive way

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Abstract

While a significant amount of research has focussed on whether bilingualism bestows advantages in cognitive skills, perspective-taking and Theory of Mind, less is known about the effect of bilingualism in communicative tasks where these and related skills may be called for. This study examines bilingual and monolingual adults' communicative skills through their production of two types of listener-adapted speech (LAS): child-directed speech and foreigner-directed speech. 20 monolinguals and 20 bilingual adults were asked to explain a cooking recipe to a child, a non-native adult and a control native adult. Participants adapted their speech for the child and the foreigner compared to the native adult. Furthermore, bilinguals adapted some features of their speech to a greater extent and in a fine-tuned way (wider pitch range addressing the child and vowel hyperarticulation addressing the foreigner). The prevalence of these features in bilingual speech was not correlated with personality or cognitive measures. We discuss possible sources of this difference in speech adaptation and implications for theories of bilingual cognition.

Keywords: bilingualism, listener-adapted speech, pragmatics

Listener-adapted speech: bilinguals adapt in a more sensitive way

It is well established that interlocutors adapt their speech to the specific conversational partner (see Lindblom, 1990; Wassink, Wright, & Franklin, 2007 among others). While "baby talk", also called "motherese" or "infant-directed speech" (IDS) is the most famous variety of "listener-adapted speech" (hereafter LAS), speakers have been found to modify the way they talk in a noisy environment (Lombard speech), to foreigners (foreigner talk or foreigner-directed speech), to the hard-of-hearing (clear speech), to elders (elderspeak or elderly-directed speech), to computers (computer-directed speech), and even to pets or to a lover (pet-directed speech and lover's talk). These different types of speech have different (segmental, suprasegmental, syntactic and lexical) characteristics resulting from the particular demands of the conversational context and purpose served by the adaptations. Common acoustic aspects include higher intensity, reduced speech rate (C. A. Ferguson, 1977; Gallaway & Richards, 1994), higher fundamental frequency, greater pitch range and sharper contours (Ferguson, 1964; Kuhl et al., 1997), fewer reductions of consonants and vowels (Bradlow, 2002; Lindblom, 1990) and vowel hyperarticulation (Bradlow, 2002; S. H. Ferguson & Kewley-Port, 2002). Common content aspects include shorter and less complex sentences, less semantic variability and increased number of repetitions (Biersack, Biersack, Kempe, & Knapton, 2005; Culbertson & Caporael, 1983; DePaulo & Coleman, 1986; Farwell, Snow, & Ferguson, 1979; C. A. Ferguson, 1977; Gallaway & Richards, 1994; Kemper, Finter‐Urczyk, Ferrell, Harden, & Billington, 1998).

Ferguson (1977) first classified the processes involved in baby talk as being of three types and serving three different kinds of purposes: simplifying, clarifying, and

expressive, which could be roughly summarised as making the processing easier, making the informational content clearer, and finally conveying emotional information. In their study, DePaulo & Coleman (1986) similarly distinguished variables relating to clarification (talking longer, using more words and a higher number of sentences, using more repetitions and paraphrases), simplification (using more content words, less complex sentences and less varied vocabulary) and "attention-maintenance" (using questions and the hearer's name). More recently, Uther, Knoll, & Burnham (2007) hypothesised that infant-directed speech has three distinct roles: linguistic-didactic, affective-emotional, and attentional, each with its own set of acoustic correlates. As such, the linguistic-didactic role of IDS would be primarily endorsed by vowel hyperarticulation and the attentional role would be realised by changes in pitch (as measured using the fundamental frequency F0). As for the affective-emotional component, it would be perceived in the "vocal affect". Uther et al. compared instances of foreigner, pet and infant-directed speech, and found that while IDS displayed all three components (linguistic-didactic, attentional and affective-emotional), pet-directed speech only contained cues related to the two latter constituents, whereas foreigner-directed speech demonstrated linguistic-didactic (vowel hyperarticulation) features, but no higher pitch or higher rated affect. An earlier study by Burnham, Kitamura, & Vollmer-Conna (2002) the same finding regarding the lack of vowel hyperarticulation in pet-directed speech compared to infant-directed speech, and several studies have shown that foreigner-directed speech's features differ from child-directed speech's, and that both are distinct from infant-directed speech (Biersack et al., 2005; DePaulo & Coleman, 1986).

With the exception of linguistically based differences between natives and non-natives (Bradlow & Bent, 2002), there has been virtually no investigations regarding

speaker variability in listener-adapted speech, despite all studies using more than one subject demonstrating a significant effect of speaker (Pisoni & Remez, 2008). Furthermore, the few studies that considered speaker variability concentrated mostly on the changes in intelligibility gains rather than examining the influence of speaker's characteristics on the amount of LAS features produced. On the other hand, a growing number of studies have produced evidence (mostly in comprehension) supporting the hypothesis that bilinguals are more sensitive to the communicative needs of their interlocutor, and generally make more use of the communication tools that are available to them[1]. This tendency is reflected through a better capacity to make use of a *combination* of tools to derive intended meaning, as well as through a greater use of *alternative* tools (i.e., communicative devices that are not pure semantic content: prosody, gestures, pragmatic and socio-pragmatic cues, etc.). In one of the only studies investigating this sensitivity from a productive point of view, Genesee, Tucker, & Lambert (1975) examined the communicative skills of bilingual children in an immersion program and found that they were better than monolingual children at taking into account the needs and characteristics of the listeners, in this case at explaining the rules of a game and conveying the appropriate information to blinded and non-blinded children. Other works have likewise found evidence indicating that bilinguals were more mindful of the thoughts, emotions and general situation of people surrounding them: bilinguals are more sensitive to feedback cues and prompts from their communicative partner (Ben-Zeev, 1977), bilingual children and adults alike are better at false-belief tasks than monolinguals and less likely to make an

[1] In this paper we will use the term 'bilingual' to refer to any individual who uses two (or more) languages (or dialects) in their everyday lives (Grosjean, 2010) with a relatively high level of fluency. Recent studies indeed seem to indicate that the benefits in cognitive abilities provided by the use and knowledge of two languages are not limited to simultaneous and balanced bilinguals who had prolonged and regular exposure to a bilingual environment(Barac & Bialystok, 2012; Kovács & Mehler, 2009; Sullivan, Janus, Moreno, Astheimer, & Bialystok, 2014).

"egocentric" error, which denotes an advantage in theory of mind (Goetz, 2003; Rubio-Fernández & Glucksberg, 2012; Ryskin, Brown-Schmidt, Canseco-Gonzalez, Yiu, & Nguyen, 2014), and have superior performances in perspective-taking tasks (Greenberg, Bellana, & Bialystok, 2013) (Greenberg et al., 2013; Han & Lee, 2013). Multilingualism and multiculturalism have also been shown to result in greater openmindedness, empathy and social initiative (Dewaele & van Oudenhoven, 2009; Dewaele & Wei, 2012), an effect correlated to advanced levels of proficiency and regular use of foreign languages (the more languages spoken at a high level, the stronger the effect). Evidence also suggests that bilingual children have superior pragmatic abilities compared to monolinguals (Siegal, Iozzi, & Surian, 2009).

There are several hypotheses regarding the underlying explanation of such a communicative advantage. This could result from enhanced executive control (EC), such as better inhibitory control (Greenberg et al., 2013) or greater working memory (Ryskin et al., 2014), from increased metalinguistic awareness, which would lead to a greater development of representational abilities and thus to a better capacity to picture another's feelings and thoughts (Goetz, 2003), from a lexical weakness that would lead them to « do more with less » and rely more on paralinguistic and pragmatic information (Carlson & Meltzoff, 2008; Siegal et al., 2009) or more generally from the bilingual's particular environment and communicative challenges, such as language monitoring, code-switching, etc. Recently, the hypothesis that these challenges led to differences in processing of speaker information has seemed to take precedence and it has been suggested that the advantage displayed by bilinguals in a variety of communicative tasks might be of a social (or socio-pragmatic) rather than purely cognitive nature (Fan, Liberman, Keysar, & Kinzler, 2015; Liberman,

Woodward, Keysar, & Kinzler, 2017; Rubio-Fernández & Glucksberg, 2012; Yow & Markman, 2016).

Those effects may not be limited to individuals who have experienced having two languages for a substantial number of years, and from the very beginning of their lives, as a number of recent studies seem to suggest. For example, Kovács and Mehler (2009) showed that by seven months of age infants growing up in a bilingual environment were already displaying improved cognitive control abilities compared to monolinguals in an eye-tracking inhibition task, well before they actively started to use their languages. Similarly, Bialystok and Barac (2012) studied groups of children in the process of becoming bilingual (what they call "emergent bilinguals") through immersion at different levels and found that their executive control capacities were correlated with the time that they had spent on the immersion program. Even a very small amount of exposure in the context of early stage second language learning appears to have an effect : Sullivan et al. (2014) examined ERP in a group of students who had been learning Spanish for six months, comparing them with monolinguals in a *go-nogo* task, and showed that the Spanish learners exhibited different neural (if not behavioural) patterns of response. This evidence indicates that the benefits in cognitive abilities provided by the use and knowledge of two languages are not limited to simultaneous and balanced bilinguals who had prolonged and regular exposure to a bilingual environment.

There is overall evidence that a bilingual advantage is evident not only in experimental tasks that measure aspects of executive control but also in tasks that study communicative interactions. An interesting avenue for research is to expand the investigation of communicative behaviour in bilinguals and monolinguals, and to explore what its relation to executive control and perspective-taking might be. This

paper aims to investigate communicative competence from the point of view of production using listener-adapted speech. Indeed, the overwhelming majority of studies in this area have focused on receptive skills. With the exception of Gullberg (2012) indicating a greater use of gestures, especially in the non-dominant language, little is known about production. another novel aspect of this research is the focus on young adults, since most research in communication in bilinguals has been carried out with simultaneous bilingual children.

In our study, we investigate a potential quantitative or qualitative effect of bilingualism on diverse aspects and types of listener-adapted speech and external factors that could be used to explain this effect. Our first goal is to replicate previous results and further examine how different categories of individuals experiencing different types of processing difficulties (children or non-native speakers) might be targeted by different types of speech adaptation. We expect that speakers will adapt in a different way depending of the type of difficulty experienced by their listener, as some adaptations might be irrelevant for a certain category of interlocutors. Our second goal is to investigate how speaker characteristics such as being bilingual might influence the production of listener-adapted speech in a quantitative or qualitative way. Given the bilinguals' greater sensitivity to the listener's perspective in comprehension, we hypothesise that they will both be more aware of their interlocutor's processing difficulties and more effortful in trying to improve the overall quality of the communication. Finally we want to find out if this greater sensitivity and adaptation is correlated to improved cognitive skills as measured by executive control, social skills such as perspective-taking, or personality variables.

Method

Participants

40 participants between the ages of 20 and 35 years old (mean= 24.45, sd=3.36) were recruited for this experiment. They were all students at the University of Cambridge. 20 were functionally monolingual English speakers (i.e., they could not hold a conversation in any other language) of diverse nationalities (English, American, Australian, New-Zealand and South Africa) (14 males, 6 females) Most of them had travelled extensively and/or lived abroad. The remaining 20 participants were highly proficient bilinguals displaying a variety of language combinations : Italian-English (*n*=1), English-Irish (*n*=3), German-English (*n*=1), English-Mandarin (n=2), Tagalog-English (n=1), English-Portuguese (n=1), French-English (n=3), Danish-English (n=1), Urdu-English (n=1), Malayalam-English (n=1), Swedish-English (n=1), Spanish-English(n=2), Russian-English (n=1) and Hebrew-English (n=1) (14 males, 6 females) and were currently living in England, outside of their country of origin. Most of them had English as their first language, sometimes along with another first language. For the other participants English was the second language. Ten of them were early bilinguals who had learned their second language before the age of 10, the rest were late bilinguals. The monolingual and bilingual groups were matched in gender (there were 14 males and 6 females in each group).

Material

Instead of using the traditional map task where the speakers have to describe a route to a listener using a map with landmarks (Biersack et al., 2005; Scarborough, Brenier, Zhao, Hall-Lew, & Dmitrieva, 2007), which leaves little room for

elaboration on the part of the speaker, we used a cake recipe in pictures (see Appendix). The visual materials describe how to prepare an apple, peach and blueberry cake using non-coloured line drawings. To ensure that the steps were clear and comprehensible, a few words of instructions were added.

The ingredients “apple”, “peach” and “blueberries” were added to provide samples of the formants for stressed instances of these three “corner” vowels that together form the vowel triangle. Likewise, target optional and non-optional adjectives (or modifiers) were added in the description of the ingredients to assess transmission of informational content.

Confederates

We decided to use three confederates (or “interlocutors”) to investigate two distinct types of listener-adapted speech registers that have been shown to present significant differences: child-directed speech and foreigner-directed speech. The first confederate (the child) was a ten-year old native English speaker from Manchester. Both the second (the non-native) and third (the control) confederates were students at the University of Cambridge in their twenties, the non-native having come from Greece for her first year of study a few months before the study was conducted and the control being a native English speaker from Canterbury. All three of the confederates were female. The confederates were videorecorded presenting themselves to the participant and asking for directions on how to make a cake. The non-native

confederate was asked to emphasise her foreign accent but her grammar was fautless. This videorecording was played to each participant at the beginning of the task.

Dependent variables

Content measures. In terms of the content of the participants' production, several measures were designed to evaluate the syntactic, semantic and pragmatic properties of listener-adapted speech, which target diverse aspects of LAS: informational content or clarification (NAW, M, OM), simplification (MLU, Ca) and redundancy (R).

Number of additional words (NAW). This is the total number of words minus the words reproducing the written instructions of the recipe, divided by the total number of words. It is thus the percentage of "additional" (i.e., not given) content in the participant's speech. The assumption, supported by the studies we mentioned earlier, is that speakers would use more content (i.e., be more detailed) in the case of listener-adapted speech.

Number of target modifiers used (M). As we have said, target modifiers were added in the description of the ingredients at the beginning of the recipe (a *big red* apple, a *big juicy* peach, a *small* peach), but were not mentioned again in the written instructions. The assumption here would be the same as for NAW, namely that speakers would make more use of adjectives in listener-adapted speech (however, see next paragraph).

Number of optional modifiers used (OM). The target modifiers that were added to the ingredients of the recipe were of two kinds: "optional" and "non-optional". *"big*" and "*small"* were necessary adjectives that had to be used to designate the peaches, since there were two possible referents for the word "peach". Those were the "non-optional" modifiers. However, optional modifiers (*big, red, juicy*) were also included

("*the **big red** apple*", "*the big **juicy** peach*") to see if they would be treated differently in the case of listener-adapted speech. The direction of the listener-adapted speech effect is, however, not certain. Indeed, it seems that the use of optional modifiers could have two possible opposite effects: help the listener by giving him a more detailed and precise picture of what is described, or confuse him by overloading his cognitive resources with useless information. According to Mangold and Pobel (1988), the use of an optional modifier in addition to a non-optional modifier will be helpful if the dimension of the former (for example, color) is more salient than the dimension of the latter (for example, size).

Mean Length of Utterance (MLU). This measure was obtained by dividing the total number of words by the total number of utterances. As is the case for OM, the direction of the listener-adapted speech effect for this particular measure is not clear. We have seen that studies of infant-directed speech have usually found a reduced MLU for speech directed to infants compared to speech directed to adults. However, there is a possibility that using sentences that are too short would break up the flow of speech and actually make the discourse less clear, whereas longer sentences would make it more homogeneous and fluent. Moreover, longer chunks of discourse tend to contain longer sentences (Rondal, 1980) and thus the speakers who give more details would also tend to produce longer sentences.

Changes (Ca). This is the number of changes made by the speaker in the written instructions given on the recipe sheet (for example, saying "mix into a smooth paste" instead of "whisk into a smooth paste", or "put the rest of the batter into the mould" instead of "pour the rest of the batter into the mould"). Once again, the direction of the effect is not easily predicted. Indeed, if some changes seem to contribute to the "simplification" of the information conveyed, others don't appear to have the same

effect. There may be other reasons why speakers would use different expressions or synonyms: because it is easier (they are more accustomed to a particular form, which may be a regionalism), because they are feeling comfortable with the interlocutor and use a less formal register, etc.

Repetitions (R). This is a measure of redundancy: the number of times part of the speech has been repeated, either with the same form or through a paraphrase. In this case, it seems safe to assume that speakers would produce more repetitions in the case of listener-adapted speech, since this is an effort that does not seem to benefit the talker (however, one could argue that some repetitions may help the speaker structure his argument and organise his thoughts).

Acoustic measures. These measures were designed to assess the extent to which the speaker modified the acoustic properties of his or her speech in order to simplify or clarify the processing of the signal.

Mean pitch (MP). This measured the mean pitch using the fundamental frequency (F0). Most types of listener-adapted speech involve a higher average pitch, with the notable exception of foreigner-directed speech (Biersack et al., 2005), we thus expect to find a higher F0 in the case of speech addressed to a child (compared to an adult native control) but not in the case of speech addressed to a non-native listener.

Pitch range (PR). This was measured by calculating the difference between minimum and maximum fundamental frequency. The direction of the effect is the same as for the average fundamental frequency: the pitch range should be extended in the case of child-directed speech, but not in the case of foreigner-directed speech.

Syllables per second (SPS). Speaking rate was measured by computing the number of syllables per second (total number of syllables divided by the speaking time in seconds). This measure includes both the changes in segment duration and in number and duration of pauses. As we have seen, most types of listener-adapted speech, including foreigner-directed speech, have been shown to display a slower speaking rate. However, child-directed speech did not demonstrate this effect in Biersack et al.'s study (2005), we thus expect that speaking rate will be slower when talking to a non-native, but not necessarily when talking to a child.

Vowel triangle area (TR). This was calculated by placing the mean first and second formant for each of the three stressed target vowels /a/, /i/ and /u/ in the diverse instances (speakers had to utter a minimum of three) of the words "*apple*", "*peach*" and "*blueberries*" on a two-dimensional graph and then computing the area of the triangle formed by the three points. According to the previous studies we mentioned earlier, this area should be more extended in the case of listener-adapted speech.

Language background and personality questionnaires

Before the experiment, participants were asked to complete a language background questionnaire and two personality questionnaires in order to crosscheck their level and type of bilingualism (or monolingualism) and to investigate the possible effect of personality factors on LAS. The first personality questionnaire (the AQ-10) was designed to assess autistic tendencies in adults (these having the opposite effect of greater perspective-taking abilities and empathy), and consisted of ten statements with which the participant could "definitely agree", "slightly agree", "slightly disagree" and "definitely disagree" (Allison, Auyeung, & Baron-Cohen, 2012). The second

personality questionnaire was a reduced version of the "Big Five" psychological traits and was designed to assess those traits in a minimum amount of time (Rammstedt & John, 2007). It likewise consisted in ten statements with which the participant could "disagree strongly", "disagree a little", "neither agree nor disagree", "agree a little" or "strongly agree".

Procedure

LAS task

Participants were given a sheet with the cake recipe and asked to read it carefully and to make sure they understood all the steps. Clarifications were given when required. Preliminary testing had revealed that subjects felt hesitant the first time they had to explain the recipe, so the first instance of explanation was a "practice" run addressed to the interviewer in order to level out the effect of the explanation turn and allow the participants to familiarise themselves with the task. Participants were informed that they would have to explain the recipe four times to four different people: first to the interviewer, as practice, and then to three interlocutors who could not be present for practical reasons, but had sent a videotape introducing themselves. The videotape of the relevant interlocutor was presented before each explanation round. The order of presentation of the three interlocutors was randomised across participants.

Participants were also told that they would be both videotaped and audio recorded, and that the recordings and videotapes would be assessed by the interlocutors, and thus they had to be as clear and understandable as possible.

The LAS part of the experiment lasted about ten to fifteen minutes. The position of the microphone was fixed and thus the participants were asked to not move their chair

and to keep the distance between them and the microphone as constant as possible. All the sessions took place in the soundproof room of the phonetics laboratory of the University of Cambridge and were recorded using a Sennheiser ME 64 cardioid microphone connected to a Tascam HD-P2 Compact Flash Audio Recorder. Recordings were made in 24bit mono with a sample rate of 44.1kHz.

Perspective-taking task

After the LAS task, participants were also asked to perform a computerised perspective-taking task based on material from Dumontheil, Apperly, & Blakemore (2010) who themselves based their computer task on the "Director's task" developed by Keysar, Barr, Balin, & Brauner (2000). In this task, the subject is asked by a "director" to move items on a grid but has to be careful not to choose items that the director cannot see (grey slots). The task was designed to record errors and reaction times.

Color-Shape Challenge

After the perspective-taking task, participants were invited to perform one last task, the "Color-Shape Challenge", which is a simple task based on the traditional Card Sort task, where the participant has to match one of two small figures to a large one on the basis of one of two dimensions: shape, or color (this test was developed online in an ongoing project by Ellefson, Serpell, and Parr, 2011-2014). This task allows the assessment of two skills, cognitive flexibility and inhibitory control, since it records reaction time differences and errors for both passing from one sorting dimension to

another and for matching figures that are congruent on both color and shape dimensions, or only on the dimension relevant to the trial.

Coding

Coding of the content

The recordings were transcribed verbatim using regular spelling, including filled pauses, repetitions, false starts and repairs. No fixed length of pausing was determined for separating the utterances; instead they were distinguished on the basis of pauses and intonation, but also grammar and meaning. However, this proved to be a difficult task. A randomly selected sample of five recordings was sent to an external rater for transcription, and there was agreement in punctuation for only 65.88% of the utterances. Given this fact, the MLU measure should be considered with caution. The transcriptions were then used to calculate the total number of words used, the number of words derivated from the written instructions in the recipe, the number of changes that had been operated on these instructions (synonyms and paraphrases were recorded, but minor changes in pronouns or prepositions were ignored; the same change performed twice was counted as two changes), the number of target modifiers used (*big, red, big, juicy, small*), the number of optional target modifiers used (*big, red, juicy*), and the number of repetitions.

Coding of the acoustic correlates

The acoustic measures were coded using Praat software. The recordings were first edited to remove sounds of laughing and coughing. For the pitch measures, the first 60 seconds (each recording being between 2 and 3 minutes long) were selected for

each recording since the address (the start of the conversation where the speaker seeks to draw the listener's attention) provided the best opportunity for pitch variations and Praat algorithms were used to find mean fundamental frequency F0, as well as minimum and maximum. Speaking rate was calculated by counting the number of syllables in each recording and dividing this number by the speaking time in seconds. For each instance of the target vowels /a/, /i/ and /u/ in the stressed context of the words "apple", "peach" and "blueberries" (usually three per vowel), F1 and F2 were measured at a point in the middle of the vowel using the Praat algorithm. The vowel triangle area was then computed from the coordinates of the points represented by F1 and F2.

Results

LAS

Separate repeated measures ANOVAS were conducted for each of the ten dependent variables. Preliminary analyses revealed no main effect of order, or bilingualism type (early vs. late) thus subsequent analyses were conducted with bilingualism and gender as between-subject factors. The within-subject factor was interlocutor (child, non-native or control).

Six of the ten measures showed a significant effect of Interlocutor: C, R, MP, PR, SPS and TRA. Pairwise comparisons showed that participants produced significantly less changes when addressing the non-native ($F(1,36) = 5.583$, $p = .024$) and the child ($F(1,36) = 5.048$, $p = .031$) compared to the control, significantly more repetitions when addressing the child ($F(1,36) = 6.886$, $p = .013$), had a significantly higher mean fundamental frequency when addressing the child ($F(1,36) = 10.877$, $p = .002$), significantly expanded their pitch range for the child ($F(1,36) = 9.938$, $p = .003$), significantly reduced their speech rate for the non-native ($F(1,36) = 4.077$, $p = .05$), and hyperarticulated vowels (i.e., expanded their vowel area) significantly more for the child ($F(1,36) = 4.782$, $p = .035$). There was, as expected, a significant main effect of gender on mean pitch ($F(1,36) = 109.160$, $p < .0001$), but also a significant two-way interaction Interlocutor*Gender, with females increasing their mean fundamental frequency for the child compared to the control significantly more than men did ($F(1,36) = 4.863$, $p = .034$). Gender has a global effect on variables such as mean pitch or pitch range, but it has also been shown to impact a range of features in listener-adapted speech: females generally exaggerate their speech more than males, produce greater intelligibility benefits, and have more empathy (Dewaele & Wei, 2012; Fernald et al., 1989; Hazan & Markham, 2004; Prato-Previde, Fallani, &

Valsecchi, 2006; Rondal, 1980). There was also a significant main effect of gender on speech rate ($F(1,36) = 5.707$, $p = .022$), with females talking generally more slowly than men regardless of who their interlocutor was. Moreover, two of the six measures displaying an LAS effect showed a significant two-way interaction Interlocutor*Bilingualism: bilinguals expanded their pitch range for the child compared to the control significantly more than monolinguals did ($F(1,36) = 6.353$, $p = .016$) (Figure 1) and hyperarticulated vowels more for the non-native ($F(1,36) = 5.315$, $p = .027$) (Figure 2), while monolinguals did the opposite (*i.e,* articulated less).

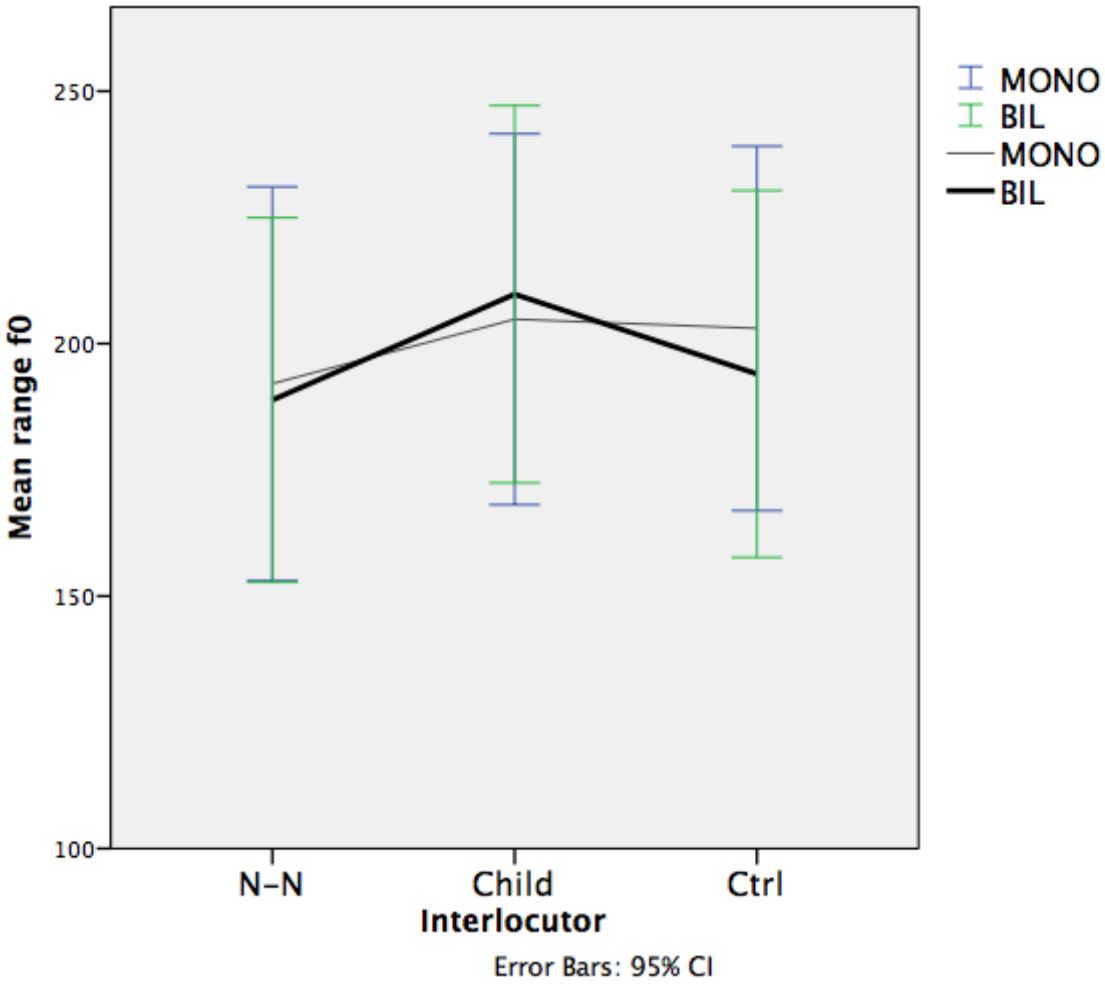


Figure 1: mean pitch range by interlocutor for bilinguals and monolinguals

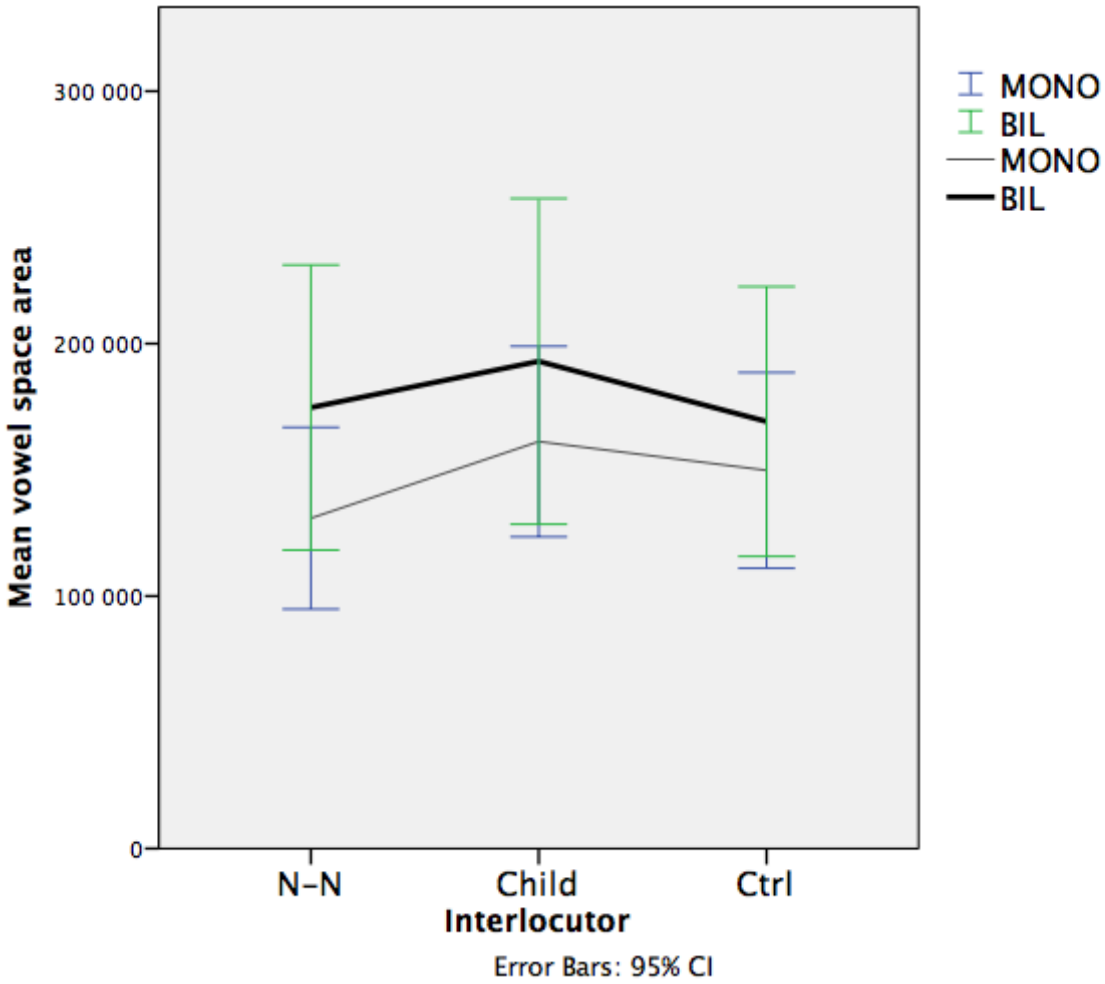


Figure 2: Hyperarticulation by interlocutor for bilinguals and monolinguals

A separate global "LAS" score was computed for the child and the foreigner by normalising and averaging the values of the variables that had yielded significant results for each type of interlocutor (i.e., C, R, MP, PR and TRA for the child and C, SPS and TRA for the foreigner[2]) and two repeated measures ANOVAs were conducted with the equivalent baseline score from the control native adult. As expected, there was a significant effect of interlocutor for the foreigner ($F(1,36) = 6.931$, $p = .012$) and edging towards significance for the child ($F(1,36)=4.005$, $p = .053$) but no interactions with bilingualism were found.

[2] According to previous results, both C and SPS were reverse-coded such that less changes and a slower speech would mean a higher score.

A one-way MANOVA was conducted with personality and cognitive measures as dependent variables (see Table 2). There was no significant effect of bilingualism, gender, early bilingualism or having English as L1 on any of the personality or cognitive variables on the multivariate or univariate tests, apart from a significant effect of bilingualism on conscientiousness: monolinguals rated themselves as significantly more conscientious than bilinguals did ($F(1,30) = 5.097$, $p = .031$)

Personality and cognitive variables

Including all 12 personality and cognitive measures as between-subject variables in the repeated-measures design would have exponentially increased the complexity of the model in a way that was not supported by the software. To avoid this, we ran separate correlation analyses between these variables and a score of LAS "effort" directed towards child or foreigner calculated by subtracting the baseline LAS control score from the child and foreigner LAS scores respectively (yielding a C_A and a N_A score).

Given the great number of possible correlations, which increased the risk of a Type I error, we only considered correlations significant at the 0.01 level. As expected, C_A was positively correlated with N_A ($r = 0.794$, $n = 40$, $p<.0001$). Conscientiousness was found to be positively correlated with performance on the inhibition ($r = 0.478$, $n = 40$, $p = .002$) and perspective-taking task ($r = 0.405$, $n = 40$, $p = .009$). No other significant correlations were found.

Discussion

The first aim of this study was to examine how participants adapted their speech for two different types of "special" interlocutors (child and non-native) compared to an adult native control. The analyses for the separate dependent variables demonstrated that participants indeed modified their speech for these addressees, using less changes for both, along with more repetitions, a higher fundamental frequency, a more expanded pitch range and hyperarticulated vowels in the case of the child, and a reduction of speech rate in the case of the non-native.

The differences found between LAS addressed to the two types of interlocutors are not surprising (Biersack et al., 2005; Uther et al., 2007; Walsh, 2006). Indeed, as we have seen, these two types of interlocutors have different needs in terms of speech adaptation, which the participants addressed accordingly and appropriately by using different types of linguistic tools. For example, using pitch modifications (which carry the attentional and affective components of LAS, Fernald, 1993; Uther et al., 2007) when addressing the non-native could result in sounding offensive and condescending (De Paulo and Coleman, 1986) without achieving much improvement in linguistic clarity. On the other hand, reducing speech rate when addressing the child might cause her to lose interest and the attentional focus that has been achieved through precisely those prosodic contrasts.

The finding that participants would use not more but *less* changes (sticking more faithfully to the original instructions for the recipe) with interlocutors who might be impaired in their linguistic processing could suggest that these changes were mostly of a "speaker-oriented" than a "listener-oriented" nature (i.e., changes that result from the speaker being more comfortable/used to some lexical items, rather than aimed at

facilitating comprehension). This could stem from being more comfortable and spontaneous in their linguistic behaviour when addressing the native control or from a conscious decision to be conservative in their lexical choices with the "impaired" interlocutors, being unsure if the listener is familiar with the particular items they would normally use. Speakers have been shown to align more with interlocutors that they perceive as less competent, such as computers (Branigan, Pickering, Pearson, McLean and Brown, 2011), and to be primed to align lexically with material that is not directly part of the conversation or common ground with the interlocutor (Foltz, Gaspers, Thiele, Stenneken and Cimiano, 2015). Thus, despite the fact that the recipe instructions were not provided by the interlocutor and did not directly reflect their lexical use, speakers might have chosen to use them more or this might have been the result of a tendency to automatically align more in cases where there is a higher risk of communication breakdown (such as when the interlocutor is experiencing processing difficulties).

As has been demonstrated in previous studies (Prato-Previde et al., 2006; Fernald et al., 1989; Rondal, 1980; Hazan and Baker, 2011; Dewaele and Li, 2012), gender appears to have an effect on LAS features, with females exaggerating their speech to a greater extent, which is indeed what our analyses show (females hyperarticulated significantly more when addressing the child than did males).

We found that bilingual participants expanded their pitch range for the child compared to the control significantly more than monolinguals did. Moreover, they also tended to hyperarticulate vowels when addressing the non-native, which monolinguals did not. This result is consistent with our hypotheses and suggests that the difference between LAS production in bilinguals and monolinguals is both a quantitative and a qualitative one: not only did bilinguals make more effort in

adapting their speech, they also did so in a sensitive and appropriate way, fine-tuning their LAS production by increasing their use of the tool most adapted to the needs of the particular type of interlocutor: pitch (used to address attentional and affective needs) for the child, and vowel hyperarticulation (the "linguistic-didactic" component of LAS, Uther et al., 2007) for the non-native, who may be experiencing linguistic difficulties, but not maturational or cognitive. Importantly, this difference was recorded for production in a population of adult simultaneous and late bilinguals. A somewhat surprising result was that monolinguals, contrary to bilinguals, hyperarticulated *less* for the non-native compared to the control. This might have been because they were more cautious about their use of hyperarticulation being perceived as offensive since they were addressing the foreigner as native speakers, whereas many bilinguals were themselves non-native speakers and thus acting as "equals". The analyses failed to reveal effects of bilingualism that previous studies have showed on cognitive variables such as flexibility, inhibition and perspective taking (Greenberg et al., 2013; Kharkhurin, 2010; Martin-Rhee & Bialystok, 2008) as well as on some personality variables such as extraversion and openness (Dewaele and Van Oudenhoven, 2009; Dewaele and Li, 2012). However, it should be noted that, as widely as the bilingual advantage in EC tasks has been reported, it is not always obtained. This is especially true for studies comparing the performance of bilingual and monolingual young adults (Antón et al., 2014; Duñabeitia et al., 2014; Goldman, Negen, & Sarnecka, 2014; Paap, Darrow, Dalibar, & Johnson, 2014; Paap, Johnson, & Sawi, 2015a, 2015b; Paap & Greenberg, 2013). Factors that may be implicated in the divergent findings include underpowered studies with small sample sizes (e.g. Paap, Johnson, & Sawi, 2015b) and failure to equate the comparison groups on several factors that may affect EC performance (ethnicity/culture, language proficiency,

socioeconomic status, non-verbal fluid intelligence, immigration status) (Katsos, Grohmann, Kambanaros & Antoniou, 2014; Morton & Harper, 2007; Paap, Johnson, & Sawi, 2015b). Alternatively, it is possible that the bilingual performance advantage in EC does not exist or is difficult to detect in young adults because at this age individuals presumably reach a peak in their EC ability with no room for further improvement. There were no correlations between the personality and cognitive measures of the participants and the prevalence of features of LAS. The lack of correlations may be down to small sample size, or measurement error, especially since we employed the abbreviated (but reportedly reliable and valid) versions of several tests. Alternatively, it may also be that the aptitude or characteristic underlying the performance in LAS is not of a cognitive nature, or directed related to personality as we measured it, and this is something that merits further research.

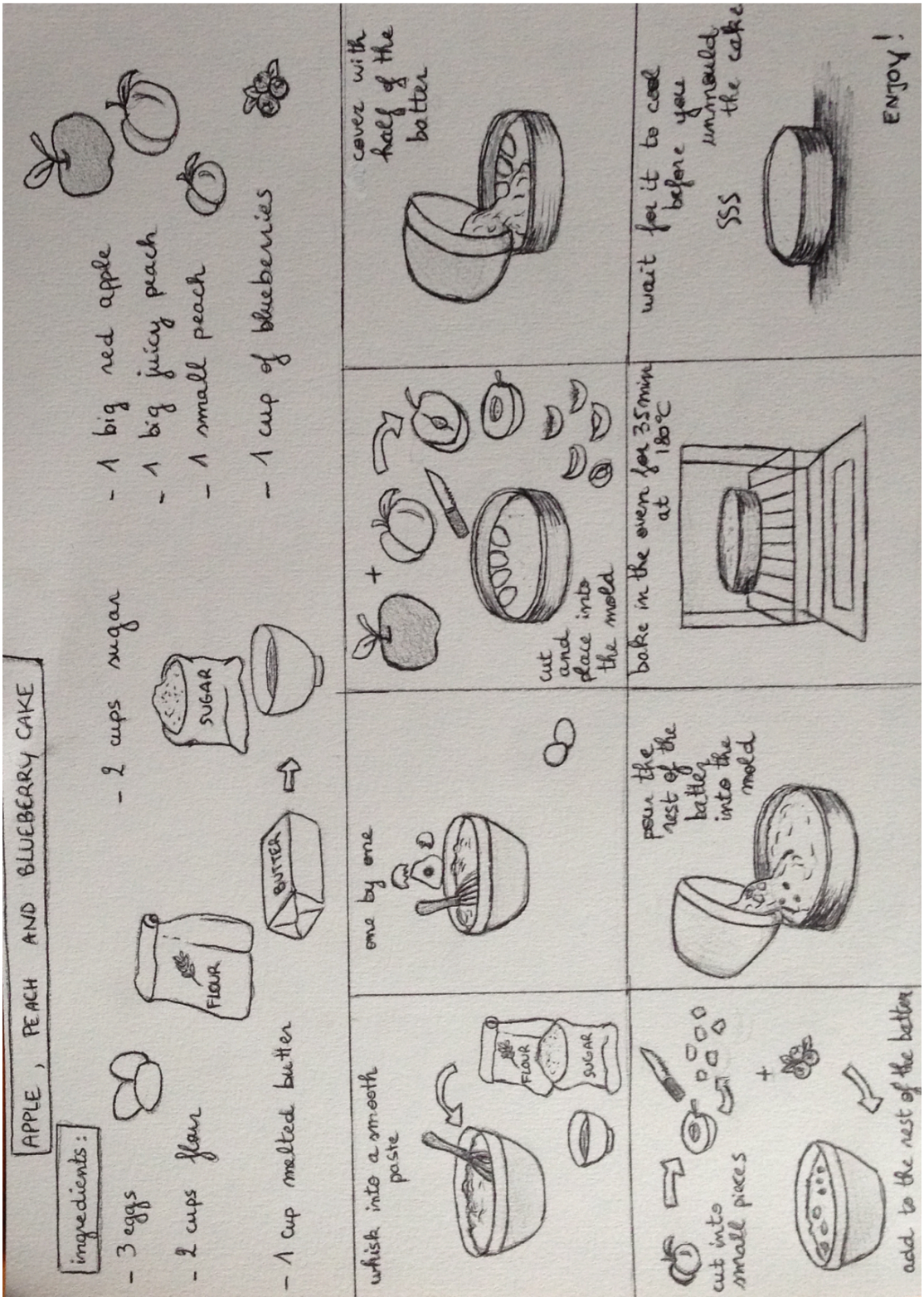
As we mentioned in the introduction, the most recent view on bilingualism suggests that any communicative advantage (in the sense of sensitivity towards interlocutor's perspective and effort directed at improving communication, which may or may not lead to actual benefits in communicative success) might be of a social more than a cognitive nature. In Fan et al. (2015), bilingual AND multilingually exposed (i.e., not productive in second language) children both outperformed monolinguals in a communication task requiring to take the perspective of the speaker (the "Director's task" presented in our study), an advantage that was not correlated with levels of executive control. Contrary to studies conducted with children and infants (Greenberg et al., 2013; Han and Lee, 2013; Fan et al., 2015; Liberman et al., 2017), but consistent with studies carried on young adults (Ryskin et al., 2014) we did not find any advantages in perspective-taking abilities in our bilingual participants. However, this might simply have been due to an effect of fluency in English and does

not rule out the possibility that a different task tapping into socio-communicative skills might be more successful in uncovering a bilingual effect, especially given that the director's task has been recently criticised as being potentially ill-suited for measuring Theory of Mind-related abilities and testing mostly cognitive abilities similar to other EC tasks (Rubio-Fernández, 2016).

Conclusion

Overall, the present research has documented that while both monolinguals and bilingual participants modified the content and form of their message towards non-typical addressees, bilinguals did so in a more nuanced way that suggested sensitivity to not just the non-typical status of the addressee in general but to the specific profile of the addressee's abilities (child versus non-native adult). The patterns of communicative behaviour elicited in the main task did not correlate with cognitive or personality traits of the participants, raising questions about the relation between the measures employed to study these traits and ecologically-valid communicative tasks.

Appendix


APPLE, PEACH AND BLUEBERRY CAKE
ingredients:
- 3 eggs
- 2 cups flour
- 1 cup melted butter
- 2 cups sugar
- 1 big red apple
- 1 big juicy peach
- 1 small peach
- 1 cup of blueberries
FLOUR
SUGAR
BUTTER
unitish into a smooth paste
one by one
cut into small pieces
add to the rest of the batter
pour the rest of the batter into the mold
cut and place into the mold
bake in the oven for 35min at 180°C
cover with half of the batter
wait for it to cool before you unmould the cake
SSS
ENJOY!

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