Speech Preparation and Articulation Time in Bilinguals and Men

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Abstract: The current study investigated the relationship between word utterance preparation time and word articulation duration in young adults. In a stratified sample, 40 monolinguals' (20 males and 20 females) and 40 bilinguals' (20 males and 20 females) word pronunciation of English words vs. derived, scrambled non-words as well as the hesitation before speaking were measured in milliseconds. Positive effects of bilingualism were found as these speakers showed significantly faster articulation of new non-words than their monolingual counterparts. Sex differences showed that independently of the number of languages men were able to speak, they needed more speech preparation time than women, but no difference in the duration of their word articulation time was observed. Preparation and articulation were correlated in monolingual speakers, but not in bilingual speakers. This suggests that the phonological loop was circumvented in bilingual speakers. We presume that bilinguals map multi-lingual phonology and were thus not saving time during preparation for articulation, but they appeared to have benefited from knowing multiple fine motor mouth movements of various languages during articulation itself. Future research may benefit from controlling the psychological factor of confidence when preparing to speak.

Keywords: Articulation preparation time, word articulation duration, bilingualism, sex differences.

When we prepare for speech output, we do take some time to think [1]. Our goal was to determine whether there are individual differences in speech preparation and articulation with a stratified sample of young monolingual and bilingual men and women. In speech perception, women were found to be faster than men in detecting prosodic differences [2], though this was not the case when women and men were following instructions [3]. Studies on speech production showed that women were also faster when repeating speech syllables [4] and the conclusion was drawn that women may be faster at programming a speech output sequence. However, managing two or more languages often leads to increased flexibility and executive attention in a number of cognitive domains [5]. Hence, our hypotheses for the current study were that, first, women should be faster in speech preparation and articulation than men, and second, bilingualism and multilingualism may have a compensating effect for men so that a speech articulation disadvantage would have disappeared in men speaking more than one language.

Psycholinguistic experiments by Levelt showed that speaking systematically follows a number of processing stages [1, 6]. The conceptual preparation activates a lexical concept that matches an intention to speak about a particular content. In a matter of milliseconds, a speaker goes from identifying the lexical target (through encoding and retrieving particular composing phonemes), to preparing the utterance and overtly articulating the initial target. During conceptualization, the intention and selection of information from either memory or the environment aid the preparation for constructing a relevant utterance [6]. If necessary, a speaker can immediately and effectively correct himself by monitoring the output [6]. Furthermore, distracters phonologically linked to nouns had an effect on articulation [7]. Hence, not just intention and semantic aspects, but also phonological surface aspects of words play a role in speaking. In addition, speakers can flexibly adapt to the size/length of speech before articulation is initiated, that is, larger units can be prepared and consequently buffered [8].

Hesitant pauses between words were shown to be related to the uncertainty of the prediction of how the sentence would proceed [9]. Pauses shorter than 250ms (micropauses) would reflect articulation difficulties rather than merely preparation time. However, this was doubted and instead it was suggested that these pauses could be also psychological rather than only linguistic, and could relate to rhetorical style preferences [10]. The current study investigates whether men may prepare speech more carefully as their strength lies more in non-verbal spatial cognition and imagery rather than in language [11]. It was pointed out that while girls and women show superior aptitude for language and are less prone to language and reading disorders, established writers and professionals such as lawyers and judges who need superior thinking and language skills were

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predominantly male [12]. This may not be the case anymore, and hence our study investigated whether indeed men would need longer to prepare for speech output.

We were also interested whether longer preparation time for articulation in men may be mediated by the number of languages an individual speaks because the constant switching between languages - and often also cultures- appears to compensate for disadvantages such as poverty [13] and even age-related illnesses such as Alzheimer disease [14].

There are still a fair amount of definitions of bilingualism [15]. Used most generously, the term may include all people who have had even minimal exposure to a second language [13, 16]. At the other extreme, the label 'bilinguals' may be restricted to people who have acquired two languages simultaneously from early childhood and who have native-like and equal proficiency in both languages [17]. Having considered the first definition that encompasses a large population world-wide [18], and the second definition that reflects more of a cognitive ideal, it is reasonable here to take into account a more appropriate and moderate application of the term. Thus, the scope of bilingualism adopted in the present study relates to the pragmatic one of Grosjean [19]: 'Bilingualism is the regular use of two (or more) languages, and bilinguals are those people who need and use two (or more) languages in their everyday lives.'(p. 51). This definition implies both regular use and communicative competence. It was expected that sex differences in preparation time and articulation duration would be less pronounced in bilingual than in monolingual speakers due to their fluency in multiple languages.

METHOD

Participants

Eighty participants between 19 and 26 years (*M*=22 years, *SD*= 2 years) from the student population of the London Metropolitan University participated in the study. The sample was stratified according to sex and number of languages spoken, and for this reason students filled out a questionnaire. Speakers with dyslexia could not participate in the study. The age of the four groups was for n = 20 male bilingual speakers (M = 22 years, SD = 2 years), n = 20 female bilingual speakers (M = 22 years, SD = 3 years), n = 20 male monolingual speakers (M = 23 years, SD = 2 years), and n = 20 female monolingual speakers (M = 23 years, SD = 2 years).

The monolingual group rated themselves as monolingual English speakers and reported exclusively speaking English. Monolingual speakers were allowed to have learned a second language in secondary school, but not higher than GCSE level which completes comprehensive schooling at age 16.The bilingual group consisted of participants who were proficient and fluent in at least two languages that were both used in everyday life. Non-English languages were Spanish, Italian, Czech, Slovakian, German, Hindi, French, Swedish, Russian, Dutch and Hungarian.

MATERIALS

Participants read aloud two word lists, each from a sheet of A4 sized paper. The first word list included 15 words that all had the same length of four syllables. We used words with a mix of frequencies from 13 to 375 to balance the less well known words with better known words [20]. However, some of the words may have been more familiar to students than to the rest of the population because they occur more often in university settings, e.g. explanation, intelligence and curriculum. Hence, the word frequency values are only for a global orientation about occurrence. The words in word list A were (word frequency in brackets; the lower the frequency, the less often the word is generally used): definition (62), inheritance (13), relaxation (13), development (375), relationship (189), explanation (64), competition (101), intelligence (35), curriculum (56), priority (54), facility (98), democracy (46), resolution (44), unemployment (64), and temperature (58). A second list with non-words was created by scrambling the words from the initial list. Some letters were changed to ensure legibility and pronunciation. The 15 non-words in Word list B (listed here in the same sequence as in word list A) contained some English phonology, but were deliberately made cumbersome to pronounce to increase the likelihood of hesitation before articulation: inidofenit, hitaincree, laxinoreta, vetepomdlen, honterpansli, nanalotiex, pinomticoet, celemimtegil, rucumrilu, tyropiri, caiflity, mardoecy, routonlies, nupontlemmey and peratmureet.

PROCEDURE

Speakers were tested individually in a Psychology laboratory by an experimenter. The experiments were conducted in English. It was explained to participants

that they could stop taking part in the experiment at any time and were offered to participate in a debriefing session after finishing the experiment should they want to. Participants were instructed to read the word list aloud, but nothing was said about the reading rate.

All participants received the same two lists. Word list A was immediately followed by list B. The identical word sequence in the lists for each and every participant made it possible to exactly compare pause lengths across participants. If the words had been presented in a randomized sequence, non-controllable interaction effects may have occurred that are known from sentence processing [8].

Utterances were audio-recorded with a digital voice recorder. The digitized sound waves of the utterance itself as well as of the pauses between utterances were measured in milliseconds in Adobe Audition by the group of experimenters. All measurements were double-checked by the second author. Hardly any mistakes were found as the measurement with Adobe Audition is remarkably safe and easy. The sound wave is highlighted with a cursor, and the duration is just read off the Adobe Audition panel. Values are quoted here in seconds, milliseconds.

If a participant needed more trials to complete the word, all of them were measured. The first word in the word list A (definition) and word list B (inidofinit) were not considered in the analyses because there was no measurable pause before the first word. Furthermore, the last words in both, word list A (temperature) and word list B (peratmureet), were excluded because of interruptions such as laughing and comments at the end of the session as the participants could gather that this was the last word on the list. The preparation time and word articulation duration of the remaining 13 words and 13 non-words were averaged across words using SPSS.

RESULTS

Articulation Time

A three-factorial 2 (sex) by 2 (language) by 2 (word type) mixed MANOVA was conducted with articulation duration of words and non-words as dependent, repeated variables to test whether bilinguals were speaking faster than monolinguals.

Not surprisingly, all speakers articulated words (*M* = .784) faster than non-words (*M* = 1.590) despite the same amount of letters, showing a clear word superiority effect, F (1, 80) = 504.34, p< .001, η_p^2 = .87. Furthermore, word articulation was significantly faster in bilinguals (*M* = 1.132) than in monolinguals, (*M* = 1.243), F (1, 80) = 7.41, p < .01, η_p^2 = .09.This shorter dwelling time of bilingual speakers on new words was further specified by a two-way interaction between word type and language groups, F (1, 80)= 15.97, p< 0.01, η_p^2 = .174. Post-hoc t-tests (two-tailed) showed that there was no difference in duration when speaking words (monolinguals *M* = .768, bilinguals *M* = .800), t(78) = 1.58, *ns*. However, monolinguals drew out their non-word utterance for significantly longer than bilinguals (monolinguals *M* = 1.718, bilinguals *M* = 1.463), t(78) = -3.43, p < 001, see Figure **1**. All statistical sex effects were not significant, p_s> .21

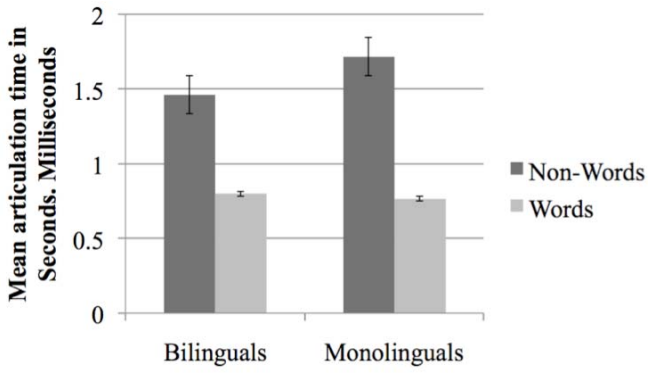


Figure 1: Bilingual speakers can articulate non-words faster than monolinguals. Error bars denote the standard error.

Preparation Time

A three-factorial 2 (sex) by 2 (language) by 2 (word type) mixed MANOVA was conducted with pauses between tokens in each list as dependent, repeated variables to test whether men needed more preparation time than women, and whether this would be different in bilingual men.

All speakers needed significantly and considerably more time to prepare for the articulation of non-words (*M* = 1.083) than words (*M* =.309), F(1, 80) = 74.77, p < .001, η_p^2 = .50. This lengthened preparation time for articulation occurred independently of how many languages participants were speaking, as all language group effects for preparation time were non-significant, p_s> .45.

However, as expected, a significant sex effect was found, F(1, 80)= 15.97, p< 0.01, η_p^2 = .174, with men (*M* = .842) needing on average 34.7% more preparation time than women (*M* = .550). This increased preparation time for speech was further specified by a marginally significant two-way interaction

between word type and sex, $F(1, 80)= 3.74$, $p = .057$, $\eta_p^2 = .05$. Post-hoc t-tests (two-tailed) showed that men needed significantly more preparation time for both words (men $M = .368$, women $M = .249$), $t(78) = -3.15$, $p < .002$, and non-words (men $M = 1.132$, women $M = .850$), $t(78) = -2.5$, $p < .05$. The interaction with word type was marginally significant because this difference between men and women was slightly more pronounced for non-words (35.4%) than for words (32.3%).

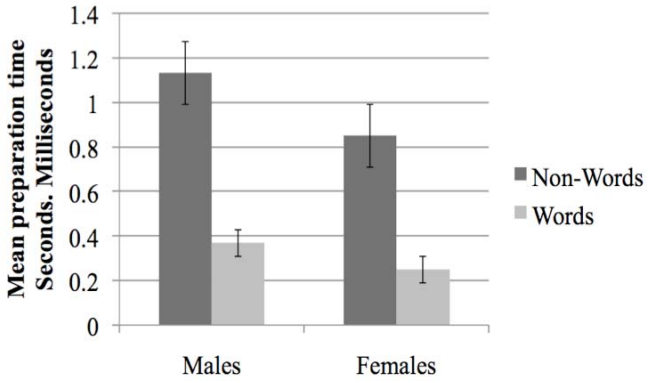


Figure 2: Men needed more preparation time to utter a word than women. Error bars denote the standard error.

Correlations between Speech Preparation and Word Articulation Duration

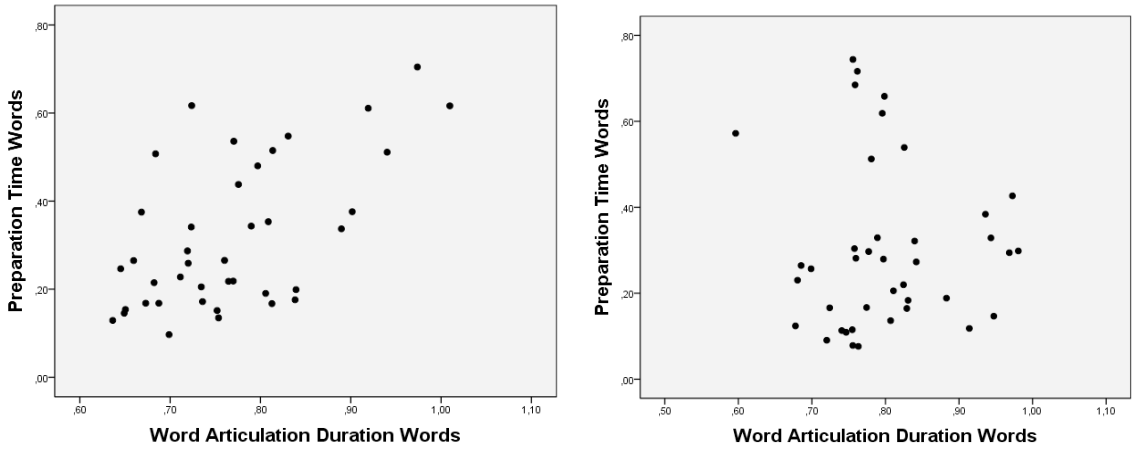
Correlations were computed between the hesitation before the actual articulation and the word articulation duration. We presumed that according to the working memory model, the phonological loop is sensitive to word length [21]. Hence, we predicted that for these long words, the length of the preparation time should be in proportion to the word articulation duration.

We found that, indeed, in monolinguals, preparation time was significantly correlated with word articulation duration, both for words, $r = .59$, $p < .001$, and for non-words $r = .40$, $p = .01$, see Figure **3A**. The more participants hesitated before articulation, the longer they also needed to articulate the word, resp. non-word. In both monolingual women and men, there was a significant correlation between preparation and articulation for words, with a slightly higher correlation in females, $r = .70$, $p = .001$, than in males, $r = .59$, $p < .01$. For non-words, though, these correlations were similar for both sexes, but not strong enough to reach significance (females, $r = .41$, $p = .08$; males, $r = .40$, $p = .08$).

However, this was not the case in bilinguals. We found that bilinguals' preparation time was not at all correlated with word articulation duration, see Figure **3B**, neither for words, $r = -.03$, $p = .86$, nor for non-words, $r = .23$, $p = .16$. The correlations between preparation and articulation were also not significant in the split samples (words: females, $r = .10$, $p = .76$; males, $r = .00$, $p = .99$; non-words: females, $r = .29$, $p = .21$; males, $r = .39$, $p = .09$).

DISCUSSION

All speakers needed longer to articulate the derived new non-words than the familiar long words, but this was particularly pronounced in monolingual speakers who would dwell much longer on their non-word utterance than participants speaking more than one language. Non-words - although identical to words in length- also needed lengthened preparation as indicated by significantly longer hesitations before



(**A**) Monolinguals (**B**) Bilinguals

Figure 3: In monolinguals, the length of the hesitation before a word (preparation time) was correlated with the length of the spoken word (word articulation duration), but this was not the case in bilingual participants.

speaking, but this occurred independently of the amount of languages that the participants could speak.

As expected [2, 4], the male participants in the study needed about one third longer than women to prepare for word articulation, and this was only slightly more pronounced for non-words than for words. This implies that men did not only need longer to prepare for difficult and unfamiliar words, but they also needed longer to prepare for speaking relatively ordinary words. Different to our expectation, men were not helped to accelerate their preparation for articulation when they spoke more than one language. Why would this be the case, when bilingualism helps in so many domains [14], and in the present study did help bilinguals to articulate non-words faster than monolinguals? This question could be answered to some degree when looking at the contingencies between preparation and articulation.

The word length effect of the working memory model predicts that the longer the words, the fewer, and the shorter the words, the more can be accommodated in the working memory sub-system of the phonological loop [22]. Hence, we expected that the time immediately before saying a word or non-word should be proportional to the articulatory difficulty that the speaker experiences, and thus preparation and articulation should be significantly correlated. Because the phonological loop is particularly engaged in language learning [23] one may have expected that this would be particularly the case for non-words. Furthermore, the engagement of the phonological loop may have been more necessary for monolinguals as they were less used to foreign language learning.

In short, we did indeed find that preparation time was significantly correlated with word articulation duration in monolinguals. In contrast, in bilinguals this correlation was not only not significant for non-words, but the correlation between preparation and articulation for words was zero. Why would this be the case? It was suggested that the phonological loop can be circumvented in word memory if the words allow for semantic associations [24]. In fact, we can presume that a similar strategy may have also occurred in the current study on word articulation. One could imagine that the bilingual participants may have engaged in matching the words and non-words with those in the lexica of the various languages that they were able to speak in everyday life [25]. Bilinguals may have come up with a fast mapping of some vaguely similar sounding word that was familiar to them, but would be 'foreign' to most other people. In contrast, monolinguals speakers may have taken an English phonology approach and deciphered the correct pronunciation based on some familiar phonological fragments that were contained in the non-words – hence the significant correlation between preparation and articulation for both words and non-words.

CONCLUSION

Hence, our conclusion is that bilingual men could not accelerate their preparation for articulation because their preparation strategy for articulation was not more economical than the one of the monolingual speakers. To scan several lexica for similar sounding words to the target word that needs to be pronounced does not suggest a better time economy than to recognize (parts of) familiar phonological word structure. However, bilingualism did help to reduce the actual word articulation duration, and there were no sex differences found in articulatory fluency. This suggested that learning the different fine motor mouth movements of various languages [26] may have benefited bilingual speakers, and particularly men as no gender differences could be found in word articulation duration. Future research may benefit from controlling the psychological factor of confidence when preparing to speak.

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