



Short Communication

British English infants segment words only with exaggerated infant-directed speech stimuli



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ABSTRACT

The word segmentation paradigm originally designed by Jusczyk and Aslin (1995) has been widely used to examine how infants from the age of 7.5 months can extract novel words from continuous speech. Here we report a series of 13 studies conducted independently in two British laboratories, showing that British English-learning infants aged 8–10.5 months fail to show evidence of word segmentation when tested in this paradigm. In only one study did we find evidence of word segmentation at 10.5 months, when we used an exaggerated infant-directed speech style. We discuss the impact of variations in infant-directed style within and across languages in the course of language acquisition.

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1. Introduction

On average, infants utter their first word around their first birthday. The ability to produce words in their native language is the first productive outcome of a long, slow learning curve during which infants store more and more word-like units. Indeed, from as early as 5 months infants are able to recognise a few familiar words under certain experimental conditions (Bergelson & Swingley, 2012; Bouchon, Floccia, Fux, Adda-Decker, & Nazzi, 2015; Tincoff & Jusczyk, 1999). Early word learning presumably reveals speech segmentation abilities that build on the storage of isolated words or short utterances (e.g. Dahan & Brent, 1999; Lew-Williams, Pelucchi, & Saffran, 2011) and rely on a combination of prosodic cues (e.g. Jusczyk, Houston, & Newsome, 1999; Mattys, Jusczyk, Luce, & Morgan, 1999), phonotactic regularities (Mattys & Jusczyk, 2000) and other statistical information (Thiessen & Saffran, 2003).

The word segmentation paradigm (hereafter, WSP), originally designed by Jusczyk and Aslin (1995), has considerably increased

our knowledge about infants' early segmentation. Typically, infants are presented with two novel words (e.g. *feet* and *bike*) in the familiarisation phase of a head-turn procedure. In the test phase, the same two now-familiar words are embedded in sentences to create two passages and presented in alternation with two passages containing two novel, unfamiliar words (e.g. *cup* and *dog*). If children are able to extract or segment the familiar words from the continuous sentences, they should listen longer to the passages containing those words as compared to those containing the unfamiliar words. This is indeed what Jusczyk and Aslin (1995) reported for 7.5-month-old American¹ infants, but not for 6-month-olds, for monosyllables. The infants performed equally well whether the isolated words were presented before the passages (word-to-passage order) or the passages were presented first and recognition of isolated words tested afterwards (passage-to-word order). Jusczyk et al. (1999) found that 7.5-month-old American infants showed evidence of word segmentation with trochaic disyllables as well.

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¹ The terms American, British and Canadian will be used to refer respectively to American English, British English and Canadian English infants or dialects. The term North American or NA will be used to encompass American and Canadian English infants or dialects.

Since then, the WSP has been used extensively to explore the conditions under which North American infants can perform word segmentation (Bortfeld & Morgan, 2010; Houston & Jusczyk, 2000; Jusczyk et al., 1999; Polka & Sundara, 2012; Schmale & Seidl, 2009; Seidl & Johnson, 2006; Singh, Morgan, & White, 2004; Singh, Reznick, & Xuehua, 2012). The WSP has also been used to investigate segmentation in different languages (Catalan and Spanish: Bosch, Figueras, Teixidó, & Ramon-Casas, 2013; Dutch and American English: Houston, Jusczyk, Kuijpers, Coolen, & Cutler, 2000; French: Nazzi, Mersad, Sundara, Iakimova, & Polka, 2014; Polka & Sundara, 2012; German: Altvater-Mackensen & Mani, 2013; Höhle & Weissenborn, 2003), and different dialects or accents. For example, Schmale and Seidl (2009) showed that when the passages were produced in an unfamiliar foreign accent, American infants could segment words across accents (and across speakers) only at 13 months and not at 9 months, and only at 12 months with non-local regionally accented speech (Schmale, Cristia, Seidl, & Johnson, 2010). Altvater-Mackensen and Mani (2013) reported successful segmentation in 7-month-old German infants when the to-be-segmented words were phonologically close to familiar words (the design of their experiments did not allow determination of whether the infants were able to segment previously unfamiliar words as in Jusczyk & Aslin, 1995).

The paradigm has also been used successfully with 8-month-old infants learning Canadian English and Canadian French (Polka & Sundara, 2012) in a word-to-passage order. In Parisian French, however, Nazzi, Iakimova, Bertoncini, Frédonie, and Alcantara (2006) failed to show evidence of disyllabic word segmentation with 8- or 12-month-olds in a word-to-passage order, and found a significant word familiarity effect only at 16 months. To understand why Parisian French infants were unable to segment words in the WSP before 16 months while 8-month-old Canadian French infants succeeded, the Canadian and the French team combined their efforts, testing children in both countries, exchanging stimuli and aligning methodological parameters (Nazzi et al., 2014). The only set-ups which produced a significant word familiarity effect in Parisian French infants at 8 months were the use of (1) a passage-to-word order with Parisian stimuli together with an increase in the number of participants (from 16 to 24; small effect size of 0.21; see their Exp 2), and (2) the use of passage-to-word order with Canadian stimuli and a longer familiarisation time (an increase from 30 s to 45 s on each passage; medium effect size of 0.28; see their Exp 6). The authors argued that the discrepancy between Parisian- and Canadian-French learning infants in their ability to segment words from continuous speech is due to Canadian French having more intonation modulations than European French (e.g. Bissonnette, 1997; see Mersad, Goyet, & Nazzi, 2010). Canadian French speakers also tend to weaken short vowels and strengthen long vowels more than European French speakers; this contributes to the two dialects having different rhythmic patterns (Walker, 1984), which might make word-final syllables more salient in Canadian French than in Parisian French in terms of pitch, intensity and duration. This difference was not particularly salient in the passage stimuli that were used in the two labs, but was clearly observed in isolated words (Nazzi et al., 2014). Perhaps the apparently greater salience of word endings in Canadian French provides Canadian infants, as compared to French infants, with more cues to facilitate segmentation from as early as 8 months.

Comparable to the findings for Canadian and Parisian French-learning infants, the current study provides evidence that British infants behave differently from North American infants in the WSP, as revealed by two sets of studies collected in parallel in two British developmental laboratories, York and Plymouth. We report a series of 13 studies – 5 in Plymouth, 8 in York, 12 of which failed to find a significant word familiarity effect in segmentation

in British infants aged 8–10.5 months. The only significant evidence of word segmentation was obtained in Exp 4, in which the speaker was requested to produce an exaggerated version of IDS as compared to a standard version in all other studies. We attempt to explain the discrepancy between NA and British results through prosodic differences in infant-directed speech style and dialect-related properties. We also discuss the implications for the use of the WSP methodology.

2. Methods

All experiments followed the standard procedure for the head-turn preference paradigm outlined in Kemler-Nelson et al. (1995). The first five experiments were carried out at Plymouth, in the South West of England, and the latter eight in York, in the North of England. Detailed descriptions of the experimental setup used in Plymouth can be found in Butler, Floccia, Goslin, and Panneton (2011) or Delle Luche, Durrant, Floccia, and Plunkett (2014); for the York experiments this information can be found in DePaolis, Vihman, and Keren-Portnoy (2014). Table 1 documents the key methodological parameters in the thirteen studies reported here. Since this report is primarily about the difficulty of replicating Jusczyk et al. (1999), Table 2 lists procedural variations among the studies reported here and between these experiments and those of Jusczyk et al. (1999).

The paradigm used in each of these experiments is the WSP described above. Briefly, for the word-to-passage order experiment, the infant is familiarised with two of four word stimuli, all four either trochaic or monosyllabic (Table 1, *Stimuli* column). Familiarisation requires the infant's head to be oriented towards the loudspeaker playing the stimuli for a specified amount of time (Table 2, *Target* column). Once the target familiarisation time is achieved, the test trials begin. During the test phase, the infant hears four passages presented in a randomized (or pseudo-randomized) order. Each passage contains one of the four words in a variety of positions.

This standard method is used in the word-to-passage order experiments (W–P in *Experiment type* column, Table 1), while the passage-to-word order (P–W, Table 1) experiments use the passages in the familiarisation phase and word lists in the test trials. In both types of experiments, a longer looking time to the familiarised words or passages during the test trials is taken to indicate that the infant has retained enough of a representation of the words to successfully extract them from the passages.

In all experiments, the passages or words used for familiarisation (vs. unfamiliarised test items) were counterbalanced across the participants

2.1. Participants

All participants were reported to be healthy and to have been born full-term with no known hearing problems. Sample sizes, age means and ranges, and attrition rates are reported in Table 1.

2.2. Design

Experiments 1 and 2 were control experiments in a larger study investigating the effect of dialect and speaker on infant segmentation. For that purpose different speakers with the same familiar dialect were used in the familiarisation and test phases. Following the unexpected null results, Exp 3 specifically addressed whether using a single speaker would elicit segmentation, as it had been showed that 7.5-month-old American infants did not generalise segmentation across speakers, in contrast with 10.5-month-olds (Houston & Jusczyk, 2000). All other experiments reported in this

Table 1

Overview of the methods used in [Jusczyk, Houston, & Newsome \(1999\)](#) and subsequent attempts to replicate it in the UK. IDS style: T for typical and E for exaggerated. Experiment type indicates the order of stimuli presented in each experiment (i.e., for familiarisation, then test): P for passage, W for isolated words. Stimuli dialect: S UK: Southern British accent; Ykshire: Yorkshire accent; Plmth: Plymouth accent; US: American accent. Age/range in months; days. Attrition: number of participants, of the total N tested, whose results could not be used. Lab column: P indicates that the experiments were carried out in Plymouth, Y indicates York.

Exp #	Stimuli	IDS style	Experiment type	Stimuli dialect	#Test trials	N	Mean age	Age range	Attrition	Lab
1	Trochees (2 speakers)	T	P–W	Plmth	12	16	10.5	8;26–10;24	3	P
2	Trochees (2 speakers)	T	W–P	Plmth	12	16	10.5	10;4–10;29	3	P
3	Trochees	T	P–W	Plmth	12	15	10	9;15–10;14	8	P
4	Trochees	E	P–W	Plmth	12	16	10.5	9;9–12;18	7	P
5	Trochees	T	P–W	Plmth	12	16	10.5	9;0–11;4	7	P
6	Trochees	T	W–P	S UK	16	24	7.5	7;12–7;28	4	Y
7	Trochees	T	W–P	S UK	16	19	9	9;0–9;13	9	Y
8	Trochees	T	W–P	S UK	16	24	10.5	10;14–10;28	1	Y
9	Mono	T	W–P	Ykshire	16	24	8	8;0–8;17	16	Y
10	Trochees	T	W–P	Ykshire	16	19	8	8;2–8;21	5	Y
11	Trochees	T	W–P	Ykshire	16	16	9	9;0–9;14	2	Y
12	Trochees	T	W–P	Ykshire	16	16	10.5	10;10–11;0	2	Y
13	Trochees	T	W–P	US	16	16	9	9;1–9;17	6	Y

Table 2

A summary of the methodological variation between this report and that of [Jusczyk, Houston and Newsome \(1999\)](#). The brackets within the column headings indicate the method employed in the [Jusczyk et al. \(1999\)](#) study. Target: Cumulative looking time per list required at familiarisation phase. Alt: Whether familiarisation stimuli alternated until both reached target looking time (Y) or once that it is reached for one stimulus, only the other is repeatedly played until it reaches target looking time (N). Masking: The babble noise was mixed from samples taken from the speech of the speaker of the stimuli in the corresponding experiment. Separate rooms: For experimenter and headturn booth. Experimenter masked: Whether experimenter wears headphones playing masker. Parent wears EP: Whether parent wears earplugs in addition to headphones. Central fixation point: +Sound – if an infant failed to look at the central green light, a bell was rung remotely by the experimenter to get her attention back.

Exp #	Target [30–45]	Alt [Y]	Masking [Music]	Separate rooms [N]	Experimenter sound masked [N]	Parent wear EP [N]	Central fixation point [Light]
1	45	N	Music	Yes	No	No	Light(+Sound)
2	45	N	Music	Yes	No	No	Light(+Sound)
3	45	N	Music	Yes	No	No	Light(+Sound)
4	45	N	Music	Yes	No	No	Light(+Sound)
5	45	N	Music	Yes	No	No	Light(+Sound)
6	20	N	Babble	Yes	Yes	Yes	Light
7	20	N	Babble	Yes	Yes	Yes	Light
8	20	N	Babble	Yes	Yes	Yes	Light
9	30	N	Babble	Yes	Yes	Yes	Light
10	30	N	Babble	Yes	Yes	Yes	Light
11	30	N	Babble	Yes	Yes	Yes	Light
12	30	N	Babble	Yes	Yes	Yes	Light
13	30	N	Babble	Yes	Yes	Yes	Light

paper used the same speaker in both phases. Following the null results of Exp 3, Exps 4 and 5 were designed to examine the effect of exaggerated infant-directed speech (IDS) on segmentation, as it was suggested that IDS prosodic cues might assist children in extracting words from continuous speech ([Fernald & Mazzie, 1991](#); [Thiessen, Hill, & Saffran, 2005](#)). Thus Exp 4 included prosodically exaggerated IDS compared to Exp 5, which – like the three preceding studies – used more typical IDS. For the Exp 4 stimuli, the speaker was asked to speak in an excited manner as if addressing children at a birthday party, while in the latter, she was asked to speak as if reading a story book to a child (see [Fig. 1](#) for illustration of the prosodic differences between the two styles).

All other experiments used, as in Exp 5, a version of IDS that was typical of the manner in which mothers address their infants in the UK. For Exps 10–13, we played the IDS to a panel of three women with young children who assessed whether the stimuli represented speech addressed to an infant. The stimuli were re-recorded, sometimes multiple times, until there was unanimous agreement from the panel on this question.

Experiments 6–8 were an attempt, in the York lab, to replicate [Jusczyk et al. \(1999\)](#). We used the stimuli from [Nazzi, Paterson, and Karmiloff-Smith \(2003\)](#), who had re-recorded those of [Jusczyk et al. \(1999\)](#) with a southern UK speaker; we also used the 20 s familiarisation time of [Nazzi et al.](#) When these experiments failed to replicate at 7.5, 9 and 10.5 months of age, we designed the remaining experiments (9–13) using the same

parameters as [Jusczyk et al. \(1999; also Jusczyk & Aslin, 1995\)](#): specifically, we increased the familiarisation time to 30 s and used a word-to-passage order in all experiments. In addition, we reasoned that the unfamiliar accent used in Experiments 6–8 might have been the reason for our failure to replicate; we therefore used a Yorkshire speaker in Experiments 9–12.

Initially, in Experiment 9, we used monosyllabic target words, as in [Jusczyk and Aslin \(1995\)](#). After a null result in this experiment, we reverted to trochees, using words and passages very similar to the original ones of [Jusczyk et al. \(1999; see Appendix\)](#). We tested progressively older infants in Experiments 10–12 (8, 9 and 10.5-month-olds) with null results. Finally, in Experiment 13, we recorded our stimuli with a US speaker to examine whether stimuli with an American IDS style would make the task easier for the 9-month-old British infants.

2.3. Stimuli

All sentence stimuli are listed in [Appendices A and B](#) and acoustic measurements for the stimuli in each experiment are presented in [Appendix C](#).

3. Results

We failed to find evidence for segmentation in any experiment but Exp 4; no other experiments, neither the word-to-passage nor

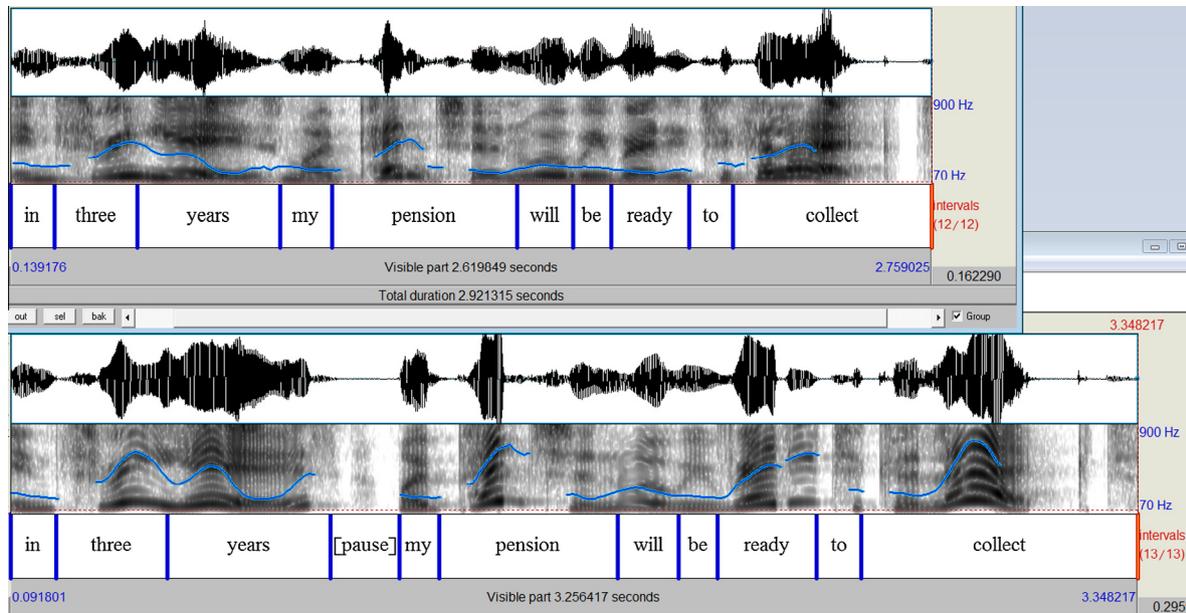


Fig. 1. Example of differences between non-exaggerated (upper panel) and exaggerated (lower panel) IDS styles used respectively in Exps 5 and 4. The waveforms/spectrograms, on the same timescales, show the greater amplitude, greater duration and higher pitch range of content words in the exaggerated style, together with more frequent/longer pauses.

the passage-to-word paradigm, produced significant results. This absence of an effect was found for groups of infants aged 8–10.5 months, across many different conditions (see [Tables 1 and 2](#)). [Table 3](#) lists the descriptive and inferential statistics for each experiment.

In contrast, in Exp 4, which used a passage-to-word order, mean listening times for the target (familiarised) words were significantly shorter than for the distracter (new) words (8.32 s vs. 10.32 s; $t(15) = -4.36$, $p < .001$). Fourteen out of the 16 infants² showed this pattern of results. The data of Exp 4 were compared to those of Exp 5, which used exactly the same speaker and procedure, apart from the strength of IDS. Importantly, the recording of the test words was exactly the same in both experiments, allowing us to test whether the IDS style used in the familiarisation phase had a direct impact on infants' segmentation abilities. In Exp 5 listening times to the target words were similar to those to the distracter words (8.25 s vs. 8.55 s; $t(15) < 1$). The interaction between experiments (4 vs 5) and the words' status (familiarised vs new) was significant ($F(1,30) = 4.96$, $p = .034$, $\eta^2 = .14$). The novelty effect found here, compared to the familiarity effect usually reported in segmentation studies, is not surprising, given the relatively advanced age of the children combined with a long familiarisation period ([Houston-Price & Nakai, 2004](#); see [Jusczyk & Aslin, 1995](#) and [Saffran, Aslin, & Newport, 1996](#), for familiarity versus novelty effects).

4. Discussion

We have reported two independent sets of attempts to elicit word segmentation responses in British-English-learning infants, using the classic paradigm first designed by [Jusczyk and Aslin \(1995\)](#). In a series of five experiments conducted in the Plymouth BabyLab with 10–10.5-month-old infants we manipulated the order of the presentation of stimuli (familiarising with passages

and testing with words or vice versa: Exps 1, 3, 4, 5 vs. 2), the number of speakers used to produce passages and words (Exps 1, 2 vs. 3, 4, 5) and the “strength” of IDS style (Exps 4 vs. 5; note that the IDS style used by the American speaker in Exp 13 was not exaggerated). In the eight York experiments we manipulated the number of syllables of the to-be-segmented words (Exp 9 vs. all others), the age of the infants (Exps 6, 7, 8 and again 10, 11, 12) as well as the dialect of the speaker (Exps 6–8 vs. 9–12 vs 13). The only manipulation that yielded a significant word segmentation effect was the use of an IDS style that was clearly exaggerated in Exp 4.

Two main findings need to be addressed separately here: the failure to replicate the original results in 12 experiments and the fact that British infants showed evidence of word segmentation only when IDS is greatly exaggerated.

The literature regarding North American (NA) infants makes it clear that slight methodological variations in the implementation of the WSP have no major impact on the observation of a significant word familiarity effect in American infants from the age of 7.5 months. For example, the use of the word-to-passage or passage-to-word order does not lead to different outcomes ([Jusczyk & Aslin, 1995](#); [Jusczyk et al., 1999](#)), nor does the duration of familiarisation, which was set at 30 s or 45 s in [Jusczyk et al. \(1999\)](#) or 30 s in [Schmale and Seidl \(2009\)](#) and [Polka and Sundara \(2012\)](#). In other words, NA infants show robust word segmentation abilities when tested in the WSP from as early as 7.5 months. The picture for European-based infants is quite different, with Parisian French infants showing segmentation in their dialect at 8 months only under very specific conditions, namely familiarisation with the passages and testing with a list of isolated words ([Nazzi et al., 2014](#)). In British infants, all the variations that we have introduced so far, using standard IDS style, failed to produce any significant result with infants aged between 8 and 10.5 months. Even when using conditions equivalent to those used by [Nazzi et al. \(2014\)](#) to elicit segmentation in 8-month-old Parisian French infants (passage-to-word order and long familiarisation time, which helped them to segment Canadian French) and raising the age to 10–11 months, we failed to find evidence of word segmentation (Exps 1, 2 and 5).

² Although the infants in Exp 4 were slightly older than any other group tested in this paper, they were not significantly older than those tested in Exp 5 ($t(30) = 1.22$, $p = .23$).

Table 3Descriptive and inferential statistics for all 13 experiments. *P*-values are for 2-tailed paired samples *t*-tests.

Exp	Stimuli	Mean looking time (s)		St. Dev		Mean age	<i>t</i>	<i>df</i>	<i>p</i>
		Target	Distractor	Target	Distractor				
1	Trochee	8.68	8.13	4.13	3.70	10	0.9	15	.40
2	Trochee	5.30	5.05	1.76	1.56	10.5	0.5	15	.62
3	Trochee	8.69	8.47	3.40	4.00	10	0.43	14	.67
4	Trochee	8.32	10.32	3.07	3.72	10.5	−4.36	15	<.001
5	Trochee	8.25	8.55	2.42	3.31	10.5	−0.5	15	.63
6	Trochee	4.64	4.92	1.95	1.60	7.5	1.7	23	.17
7	Trochee	4.46	4.65	1.45	1.43	9	0.4	18	.67
8	Trochee	5.33	5.41	1.67	1.67	10.5	0.2	23	.84
9	Mono	5.01	5.26	1.49	1.80	8	0.8	23	.43
10	Trochee	5.20	4.96	1.59	1.69	8	0.7	18	.47
11	Trochee	6.37	6.01	2.63	3.60	9	0.6	15	.53
12	Trochee	4.83	5.22	2.22	2.02	10.5	0.8	15	.45
13	Trochee	5.13	4.93	1.75	2.38	9	0.3	15	.74

An argument could have been made that the task presented to the infants in the Plymouth lab was more difficult than that used in previous studies, because contrary to all previously mentioned studies, target words were never located in sentence-final position (see Appendix A). However, the passages used in the York experiments were the same as those used in Jusczyk et al. (1999), with some changes to the target words but with the carrier sentences mostly left unchanged (see Appendix B), so that words appeared both medially and finally. Therefore, word position within the sentences cannot explain the full set of results presented here.

It could also be argued that the relatively short familiarisation time used in York (20 s on each passage in Exps 6–8 and 30 s in Exps 9–13) increased the difficulty of the task for those infants – although 20 s is the same as the time used in Nazzi et al. (2003), and 30 s is the same as the time used in the first three experiments in Jusczyk and Aslin (1995) and in all word-to-passage experiments in Jusczyk et al. (1999). Recall that with Parisian French infants, the only situation in which Nazzi et al. (2014) reported evidence of segmentation at 8 months in Canadian French was with an increase of the familiarisation time to each passage from 30 to 45 s. However, in Plymouth familiarisation time was 45 s throughout the five experiments and yet no evidence of segmentation was found in four of them, which speaks against the strong role of this variable in explaining the British segmentation results. It is possible, however, that the segmentation task is sensitive to some or all of these variables, and that if only they had all been combined in a specific way with standard IDS (presentation of passages preceding that of words, certain speaker voice characteristics and speaking style, longer familiarisation and positioning of target words at the edges of the sentences), British 10.5-month-old infants would have shown signs of successful segmentation.

Perhaps in York and Plymouth there are extra-experimental features that differ from those in the American labs and that we have failed to identify as relevant to the experimental findings (see Maurer, 1993, for such an example with early cross-modal visual preferences). We should emphasise, however, that using the same implementation of the basic head-turn preference paradigm, both our labs have produced significant publishable findings on topics other than segmentation (Butler et al., 2011; Delle Luche et al., 2014; DePaolis et al., 2014).

Given that it is unclear whether the discrepancy between the British and American studies can be wholly explained by methodological nuances, we are left with the possibility that linguistic or sociolinguistic factors underlie British English infants' failure to display an ability to segment on the same timescale as American infants unless presented with exaggerated IDS style.

It is relevant to point out that there is a well-established (but as yet unexplained) gap in vocabulary size between British and American infants (Hamilton, Plunkett, & Schafer, 2000), as measured by parental report on the British and American versions of the Communicative Development Inventories (Dale et al., 1993; Fenson et al., 1994). American infants' vocabulary is typically found to be significantly larger than that of their British peers throughout their first three years. In Fenson et al. (1994), vocabulary scores from 1344 American children between 0;11 and 2;0 were compared to those from 669 British children aged between 1;0 and 2;1 (Hamilton et al., 2000). At age 1;4, for example, about half of the words in the MacArthur CDI are understood by American toddlers, whereas only a quarter of the words in the Oxford CDI are understood by British toddlers. The same differences apply to the timing of word production.

Cultural explanations for this discrepancy are possible, as British parents may be more cautious in reporting their children's performance (Houston-Price, Mather, & Sakkalou, 2007), whereas American parents might be over-estimating their child's knowledge (Tomasello & Mervis, 1994). However, there may equally well be genuine cross-cultural differences in early linguistic abilities, which could explain why the English infant participants were unable to segment at 10.5 months while their American peers have been found to do so successfully at younger ages.

A possible reason for the difference between British and North American infants in the WSP task (and, a fortiori, in vocabulary scores) has to do with IDS style, a more broadly sociolinguistic or cultural difference that may also have structural or linguistic impact. A cross-linguistic study of natural infant-directed speech (Fernald et al., 1989) found more extreme prosodic modifications in IDS by American parents relative not only to British parents but also to French, Italian, German and Japanese parents. DePaolis, Keren-Portnoy, and Vihman (2010) asked American and British mothers to "read" (or talk through) a picture book to their 8-month-old infant at home, in order to elicit natural IDS. A preliminary analysis of the resulting corpus showed that American IDS typically features greater prosodic differences between target words (in this case, the names of objects pictured in the book) and preceding speech, which would boost the salience of the target word. The authors also reported longer pauses following target words in American IDS, which featured these words more frequently as single-word utterances, or in utterance-final position, than did British IDS. Similarly, an analysis of spontaneous input speech by both parents in the same families found significantly higher variability (SD) in F0 values for the American as compared with the British parents (White, 2012). All of these features, which

are typical of IDS in general and of American IDS in particular, have been reported to facilitate segmentation (Thiessen et al., 2005; see also Fernald & Mazzei, 1991).

Being exposed from birth to such an extreme form of IDS could have other positive consequences for word learning. First, infant's overall engagement with speech might be boosted, as it is well established that infants prefer to listen to IDS over ADS from birth (e.g. Fernald, 1985), perhaps because it supports pre-verbal communication (Papoušek, Papoušek, & Symmes, 1991) or helps to regulate infant attention (Fernald, 1985). Second, whole content words would be more strongly prominent at the phrasal level, through higher F0, greater duration, and, as seen in DePaolis et al. (2010), longer pauses, which would facilitate their extraction. Third, lexically stressed syllables would have higher pitch in IDS over ADS, less so unstressed syllables (Wang, Seidl, & Cristia, 2015), enhancing the contrast between stressed and unstressed syllables and therefore aiding metrical segmentation (see also evidence for greater durational differences between stressed and unstressed syllables in IDS: Albin & Echols, 1996). Finally, more repetition and higher frequency of pausing should also serve to boost word learning. Altogether, these features could potentially contribute to boost performance in the laboratory context, as we found in Exp 4 that exaggerating IDS for British infants allowed them to extract words from continuous speech. But, more importantly, it could be that the bootstrapping from real world experience gives the American-learning infants an overall head-start in word-recognition, which they take into the lab.

Interestingly, one British lab (at the University of Reading) has replicated the WSP findings with British infants, albeit at an older age than in the original NA studies – 10.5 months (Mason-Apps, 2014; Mason-Apps, Stojanovik, & Houston-Price, 2011; using the head turn software developed by the Plymouth Babylab). The procedure used the word-to-passage order with 20 s familiarisation time and the same trochaic words and passages as in Jusczyk et al. (1999). Our explanation is that the level of IDS in that study, which was described as a lively motherese voice (Mason-Apps, 2014), may have been sufficient to induce segmentation, as was found in Exp 4. It must be noted that with similar recordings Mason-Apps failed to show segmentation of iambic disyllabic words, which was found by Jusczyk et al. (1999) at 10.5 months with American infants.

In conclusion, our data suggest that, within the same language, infants exposed to two different dialects follow contrasting trajectories in developing abilities to segment unfamiliar words from continuous speech: British infants lag behind North American infants when tested in a traditional word segmentation paradigm (Jusczyk & Aslin, 1995) with a level of IDS typical of what is used in their dialect. Although it remains possible that methodological differences (either those highlighted above or others not yet identified) might explain at least some of the differences in the patterns of results in the two populations, our findings point towards a real difference in the developmental trajectories of infants in Britain and NA. Indeed, as mentioned, previous observations have shown that British toddlers tend to know and produce fewer words than their American counterparts until the age of 2 years (Hamilton et al., 2000). We argue that the different styles of IDS used on the two sides of the Atlantic might provide American infants with a head start in the process of word learning. This claim is justified by the finding that only an exaggerated version of British IDS can produce segmentation performance in British infants.

Future research should more systematically examine the relationship between parental use of IDS and infants' segmentation abilities, both in the UK and in the US. It is clear from the current

study and the French Canadian and Parisian comparison (Nazzi et al., 2014) that researchers need to be increasingly alert to the possibility that within-language dialectal or IDS-style variations could have a noticeable impact on infants' behaviour in classic language development paradigms (e.g. familiar word recognition using preferential looking as in Durrant, Delle Luche, Cattani, & Floccia, 2014, or Floccia, Delle Luche, Durrant, Butler, & Goslin, 2012). Further research will be needed to evaluate whether similar differences in word segmentation abilities will be found within and across languages as a function of IDS or other dialectal idiosyncrasies.

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Appendix A. Plymouth stimuli

A.1. Passages with trochaic words used in Exps 1–3

1. The **carriage** was pulled by two big white horses. He gave her a **carriage** clock for Christmas. The gentle footman looked after the **carriage** well. A train pulls a **carriage** with a lot of people in it.
2. The **dialect** differs in various parts of the country. The vowels in your **dialect** determine how you speak. The Newcastle **dialect** is perhaps the strangest. In each region people use a **dialect** to talk.
3. The **pasture** over the hill was lush and green. The cows and pigs live on the **pasture** on the farm. All over the **pasture** were beautifully yellow primroses. While grazing on the **pasture** the cows fell asleep.
4. A **tourist** goes to London to see the sights. St Paul's cathedral had a **tourist** trapped in it once. You are called a **tourist** everywhere when on holiday. My husband is going to be a cricket **tourist** at the end of May.

A.2. Passages with trochaic words used in Exps 4 and 5

1. The **carriage** was pulled by two big white horses. He gave her a **carriage** clock for Christmas. The gentle footman looked after the **carriage** well. A train pulls a **carriage** with a lot of people in it.
2. The **dialect** differs in various parts of the country. The vowels in your **dialect** determine how you speak. The Newcastle **dialect** is perhaps the strangest. In each region people use a **dialect** to talk.
3. A bungalow is a **dwelling** but so is a mansion. Being in the world can be explained as a **dwelling** for real. The **dwelling** is so large you can lost in it. His **dwelling** was small and shabby inside.
4. My **pension** pays for my weekly bingo trips. You pay into a **pension** all of your working life. Elderly women can claim their **pension** every day. In three years my **pension** will be ready to collect.

Appendix B. York stimuli

B.1. Passages with trochaic words – Exps 6–8 (stimuli identical to those used in *Nazzi et al., 2003*)

Your **kingdom** is in a faraway place. The prince sailed past that **kingdom** last summer. He saw a ghost in this old **kingdom**. The **kingdom** started to worry him. He went to another **kingdom**. Now the big **kingdom** makes him happy.

The **doctor** saw you the other day. He's much younger than the old **doctor**. I think your **doctor** is very nice. He showed another **doctor** your picture. That **doctor** thought you ate a lot. Maybe someday you'll be a big **doctor**.

Your **hamlet** lies in a valley. Far away from here is an old **hamlet**. The kids from the **hamlet** often sing. Another **hamlet** is in the country. People from that **hamlet** like to farm. They live in a rather big **hamlet**.

The **candle** that you like has melted. She bought another **candle** at the shop. You put away the old **candle**. He gave that **candle** to you later. She found a place for the new big **candle**. Your **candle** is pretty and smells nice.

B.2. Passages with monosyllabic words – Exp 9

The **cup** was bright and shiny. A clown drank from the red **cup**. The other one picked up the big **cup**. His **cup** was filled with milk. Meg put her **cup** back on the table. Some milk from your **cup** spilled on the rug.

The **dog** ran around the yard. The postman called to the big **dog**. He patted his **dog** on the head. The happy red **dog** was very friendly. Her **dog** barked only at squirrels. The neighbourhood kids played with your **dog**.

The **feet** were all different sizes. This girl has very big **feet**. Even the toes on her **feet** are large. The shoes gave the man red **feet**. His **feet** get sore from standing all day. The doctor wants your **feet** to be clean.

His **bike** had big black wheels. The girl rode her big **bike**. Her **bike** could go very fast. The bell on the **bike** was really loud. The boy had a new red **bike**. Your **bike** always stays in the garage.

B.3. Passages with trochaic words – Exps 10–13

Your **kingdom** is in a faraway place. The prince sailed past that **kingdom** last summer. He saw a ghost in this old **kingdom**. The **kingdom** started to worry him. He went to another **kingdom**. Now the big **kingdom** makes him happy.

The **chaplain** met you the other day. He's much younger than the old **chaplain**. I think your **chaplain** is very nice. He showed another **chaplain** your picture. That **chaplain** thought you looked quite well. Maybe someday you'll be a big **chaplain**.

Your **temple** lies in a valley. Far away from here is an old **temple**. The kids in the **temple** often sing. Another **temple** is in the country. People from that **temple** like to farm. They live near a rather big **temple**.

The **goblet** that you like has broken. She bought another **goblet** at the shop. You put away the old **goblet**. He gave that **goblet** to you later. She found a place for the new big **goblet**. Your **goblet** is shiny and looks bright.

Appendix C. Acoustic measures for stimuli from Plymouth and York

C.1. Plymouth stimuli

Exps 1–3 – Passages (4 sentences repeated once; measures for the entire sound files). In Exp 3 half of the children heard Speaker 1 in both familiarisation and test and the other half heard Speaker 2.

		F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Carriage	Speaker 1	203.3	52.9	60.3	30.2
	Speaker 2	196.3	56.9	55.1	25.0
Dialect	Speaker 1	207.2	46.1	61.8	29.5
	Speaker 2	192.7	50.6	56.8	26.5
Dwelling	Speaker 1	208.7	46.2	62.6	30.3
	Speaker 2	175.0	35.0	57.4	25.3
Pension	Speaker 1	212.0	51.7	61.6	27.7
	Speaker 2	199.2	53.1	57.2	24.2

Exps 1–3 – Word lists (measures for the entire sound files, made up 15 tokens of each word).

		F0 Mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Carriage	Speaker 1	263.7	114.5	62.9	21.5
	Speaker 2	210.4	55.6	57.3	15.7
Dialect	Speaker 1	241.7	67.1	63.6	23.9
	Speaker 2	214.7	72.1	59.7	17.5
Pasture	Speaker 1	254.3	115.0	61.4	19.5
	Speaker 2	210.1	58.7	57.0	17.2
Tourist	Speaker 1	297.6	117.8	62.8	22.5
	Speaker 2	207.0	64.0	60.3	16.9

Exps 4 and 5 – Passages (4 sentences repeated once; measures for the entire sound files). Typ IDS stands for Typical IDS (Exp 5) and Ex IDS for Exaggerated IDS (Exp 4).

		F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Carriage	Typ IDS	289.4	105.9	75.5	25.0
	Ex IDS	324.5	119.1	78.6	29.0
Dialect	Typ IDS	288.1	105.7	77.4	26.0
	Ex IDS	313.1	116.5	78.1	29.0
Dwelling	Typ IDS	288.3	104.1	76.9	27.0
	Ex IDS	308.9	110.0	78.8	28.0
Pension	Typ IDS	285.0	93.2	78.1	25.0
	Ex IDS	313.0	111.9	78.8	29.0

Exps 4 and 5 – Word lists (measures for the entire sound files made of 12 tokens of each word repeated once).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Carriage	289.1	125.7	72.2	26.0
Dialect	276.1	118.9	73.4	27.4
Dwelling	259.3	110.1	70.2	25.6
Pension	290.8	131.9	74.4	27.5

C.2. Yorkshire stimuli

Exp 9 – Word lists (measures for the entire word lists, made of 20 tokens).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Bike	303.8	101.6	67.6	22.9
Cup	299.9	95.5	68.6	19.8
Dog	278.3	105.6	68.3	22.2
Feet	310.6	99.8	66.9	20.6

Exp 9 – Passages (measures for the entire passages).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Bike	202.7	56.5	70.5	17.2
Cup	215.9	53.5	69.9	16.8
Dog	220.2	54.3	69.2	17.0
Feet	209.7	47.1	67.2	17.9

Exps 10–12 – Word lists (measures for entire word lists, made of 20 tokens).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Goblet	266	118.41	65.50	23.27
Temple	283	113.29	66.26	23.90
Kingdom	272	100.34	67.24	23.00
Chaplain	250	112.27	65.66	23.96

Exps 10–12 – Passages (measures for entire passages).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Chaplain	206.5	57.9	68.8	19.19
Kingdom	207.6	65.8	67.9	19.54
Goblet	203.9	51.1	66.9	19.50
Temple	208.6	66.4	67.2	20.70

Exp 13 – Word lists (measures for entire word lists, made of 20 tokens).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Chaplain	305	129.0	63.8	25.9
Goblet	291	111.5	65.2	25.7
Kingdom	280	115.6	63.2	26.9
Temple	291	91.8	61.9	26.0

Exp 13 – Passages (measures for entire passages).

	F0 mean (Hz)	F0 SD	Intensity mean (dB)	Duration (s)
Chaplain	241.2	65.5	67.7	18.4
Goblet	257.9	62.9	68.2	17.4
Kingdom	257.0	71.8	66.5	18.0
Temple	248.6	74.6	65.8	18.4

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