

REGIONAL DIALECT INTELLIGIBILITY ACROSS THE LIFESPAN

Cynthia G. Clopper and Laura Wagner

Ohio State University
clopper.1@osu.edu, wagner.602@osu.edu

ABSTRACT

The developmental trajectory of sociolinguistic competence extends into adolescence. The goal of the current study was to explore this trajectory for regional dialect intelligibility. Participants in the American Midwest ranging in age from 4-79 years completed a phrase intelligibility in noise task with stimulus materials produced by female talkers from the Midland, New England, Northern, and Southern dialect regions of American English. The results revealed significant effects of talker dialect across the lifespan: Midland talkers were most intelligible, followed by Northern and Southern talkers, followed by New England talkers. Intelligibility accuracy reached an adult-like level at age 12-15 years, in parallel to the age ranges at which adult-like language attitudes and dialect classification are observed. Intelligibility accuracy also declined after age 50 years, consistent with overall decreases in speech intelligibility and dialect classification with aging. These results suggest close connections in the development of different perceptual domains of sociolinguistic competence.

Keywords: regional dialect, intelligibility in noise, language development, sociolinguistic competence

1. INTRODUCTION

Sociolinguistic competence has been proposed to exhibit a protracted developmental trajectory, in which adult-like performance is not achieved until adolescence [18]. Recent research in the domain of dialect perception has provided evidence in support of this proposal [e.g., 16, 23]. Although children as young as 4-5 years can accurately categorize some talkers by regional or ethnic dialect [11, 16], adult-like accuracy in regional dialect classification is not observed until 14-17 years [16, 24, 32]. Similarly, although preschool-aged children exhibit social preferences for talkers who share their native variety [9, 17], adult-like language attitudes are not in place until 10-13 years [10, 23]. The goal of the current study was to explore the development of a third dimension of regional dialect perception: cross-dialect intelligibility.

Previous research with adults has shown that speech intelligibility is more accurate for familiar

dialects than for less familiar dialects [e.g., 7, 14, 20, 22, 30, 33]. For example, Labov and Ash [20] found that Southern talkers were more intelligible for listeners from Birmingham, Alabama, than for listeners from Chicago or Philadelphia, suggesting a processing benefit for local varieties. In addition, Clopper and Bradlow [7] found that General American talkers were more intelligible than Northern talkers for both General American and Northern listeners, suggesting a processing benefit for standard varieties.

Much of the previous research on cross-dialect intelligibility with children has focused on infants and toddlers, revealing incremental improvement in the intelligibility of unfamiliar varieties from 15 to 25 months [e.g., 3, 25, 31]. Studies exploring dialect intelligibility in school-aged children (4-12 years) have demonstrated consistent familiar dialect benefits for a range of regional and racial varieties [2, 15, 26, 27, 28, cf. 6]. However, explicit comparisons between the results for adults and children are difficult, due to differences in task design and stimulus dialects. One exception is the work by Jacewicz and Fox [14, 15], in which the same task and materials were used with adults and 9-12 year olds [see also 1, 2]. Their results showed that the children's intelligibility performance was worse than the adults', suggesting continued development in cross-dialect intelligibility into adolescence.

The current study explored the developmental trajectory of regional dialect intelligibility in noise for listeners ranging in age from 4-79 years. The study involved listeners in the American Midwest and stimulus talkers from the Midland, New England, Northern, and Southern American English dialect regions. These talker and listener characteristics are similar to those in Clopper and Bradlow's [7] study, in which Midwestern adult listeners were presented with stimulus talkers from the General American, Mid-Atlantic, Northern, and Southern dialects. We therefore expected to observe parallel results: the adult listeners in the current study were expected to show an intelligibility benefit for Midland talkers, who are most similar to General American talkers [19]. The Northern and Southern talkers were expected to be less intelligible than the Midland talkers and the New England talkers were expected to be the least intelligible. The Mid-Atlantic and New England dialects are phonetically distinct [21], but

Midwestern listeners find them highly confusable [8], suggesting similarly low intelligibility for these two varieties for Midwestern listeners. Based on previous work [e.g., 26, 27], we expected children as young as 4 years to exhibit intelligibility differences between these regional dialects and that adult-like accuracy would emerge in adolescence, in parallel to the developmental milestones observed in other perceptual domains of sociolinguistic competence [e.g., 10, 16, 23, 24, 32].

2. METHODS

2.1. Participants

325 participants were recruited from among the visitors to a science museum in the American Midwest. All participants were native speakers of American English with no self-reported history of speech or hearing disorders. The participants ranged in age from 4-79 years. Children aged 4-7 years completed the intelligibility in noise task with a relatively easy signal-to-noise ratio (SNR) of +6 dB to ensure some success with the task. Children aged 12-17 years and adults completed the task with a harder SNR of +1 dB to avoid ceiling effects. As in Jones et al.'s study [16], children aged 8-11 years completed the task with one of the two SNRs in a between-subject design so that the developmental trajectory in performance could be assessed across SNRs. The numbers of participants in each age group in each noise condition are shown in Table 1.

Table 1: Numbers of participants in each age group for each noise condition.

Age Group	+6 dB SNR	+1 dB SNR
4-5	20	
6-7	28	
8-9	25	26
10-11	22	24
12-13		29
14-15		30
16-17		27
18-34		39
35-49		30
50-79		25
Total	95	230

The majority of the participants (N=212, 65%) were lifetime residents of the American Midwest, which includes both the Midland and Northern dialect regions. A small percentage of participants were lifetime residents of the other regions included in the stimulus materials: New England (N=4, 1%) and South (N=26, 8%). The remaining participants were lifetime residents of other American English dialect

regions (N=15, 5%) or had lived in more than one dialect region (N=68, 21%).

2.2. Stimulus materials

The stimulus materials comprised short phrases extracted from sentences produced by three female talkers from each of four American English dialect regions (Midland, New England, North, and South) from the TIMIT Acoustic-Phonetic Continuous Speech Corpus [13]. Two unique phrases were selected for each talker, for a total of 24 targets. As in Clopper and Bradlow's [7] study, the phrases were selected to contain dialect-specific segmental features so that dialect differences in intelligibility could be observed. These features included /ɔ/ lowering in the Midland; r-lessness, /æ/-raising, and /ɔ/ lowering in New England; /æ/-raising, /ɑ/ fronting, and /ɛ/ backing in the North; and /ɑj/ monophthongization, /u/ fronting, and /i/ lowering in the South [21]. Prosody was not considered in stimulus selection, although it varies across dialects in the TIMIT corpus [5]. The six target stimulus phrases for each talker dialect are shown in Table 2.

Table 2: Target stimulus phrases for each talker dialect.

Dialect	Target Phrases
Midland	autumn leaves, his legs, long black hair, on the safari, the flower beds, the gorgeous butterfly
New England	a crab, all year, greasy wash water, peeling an orange, the two artists, your dark suit
North	adhesive tape, blue feather, in a man's hat, ten thousand, the icy antarctic, the small lake
South	a large piece, bobcat and hyena, pine trees, the blue rug, the ironing board, wild animals

2.3. Procedure

Participants were seated at a personal computer in a dedicated lab space in a science museum. For all participants, the 24 target stimulus phrases were presented one at a time in random order for identification. For children aged 4-7 years, the phrases were mixed with speech-shaped noise at a SNR of +6 dB. For children aged 8-11 years, the phrases were mixed with speech-shaped noise at a SNR of either +6 dB or +1 dB, in a between-subject design (see Table 1). For children aged 12-17 years and for adults, the phrases were mixed with speech-shaped noise at a SNR of +1 dB.

Children aged 4-11 years were asked to listen to the phrases over headphones and repeat the phrase aloud. To ensure that repetitions reflected lexical access and were not simply phonetic imitations [26], the children were then asked to define or explain what the phrase meant. The children's responses were coded in real-time by the experimenter and audio-recorded so the reliability of the real-time coding could be assessed. Offline coding of 20% of the recorded data revealed reliability of 94% with the real-time coding. The real-time coding was therefore deemed reliable and used in the analysis. Children aged 12-17 years and adults were asked to listen to the phrases mixed with noise and type what they heard using the computer keyboard. These typed responses were hand-corrected for obvious typographical errors (e.g., *aotumn* for *autumn*).

All of the responses were coded for accuracy based on the proportion of keywords correctly reported for each target phrase. Keywords were defined as all content words in the phrase and each phrase contained 1-3 keywords. The set of keywords varied in lemma log frequency from 1.32 to 4.97 [4], but did not differ significantly across talker dialects ($F(3, 42)=0.33, ns$). An exact match for all morphemes was required for the response to count as correct (e.g., *leg* was incorrect for *legs*).

3. RESULTS

The mean by-subject keyword accuracy scores were submitted to repeated measures ANOVAs with talker dialect as a within-subject factor and participant age group as a between-subject factor, separately by noise condition.

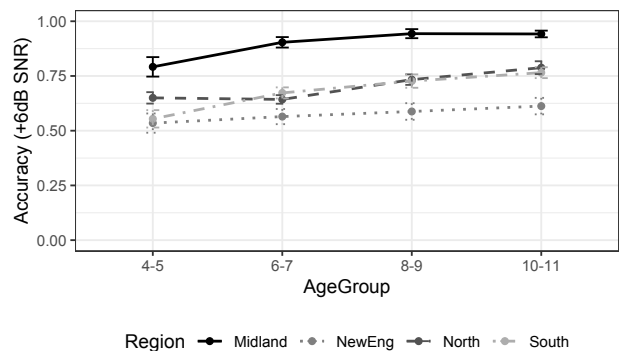
3.1. Easier +6 dB SNR condition

A summary of the keyword accuracy for each talker dialect for each age group in the easier +6 dB SNR condition is shown in Figure 1. The repeated measures ANOVA revealed a significant main effect of talker dialect ($F(3, 273)=107.46, p<.001$) and a significant main effect of age group ($F(3, 91)=8.78, p<.001$). The interaction was not significant.

Post-hoc paired-sample t-tests with Bonferroni correction ($\alpha=.008$) on talker dialect revealed that Midland talkers were significantly more intelligible than Northern and Southern talkers, who were significantly more intelligible than New England talkers, as expected. Post-hoc independent sample t-tests with Bonferroni correction ($\alpha=.008$) on age group revealed significantly higher accuracy for 8-11 year olds than for 4-5 year olds and for 10-11 year olds than for 6-7 year olds, suggesting continued development in cross-dialect intelligibility

throughout this age range, as expected. The lack of a significant interaction suggests that although overall performance improved with age from 4 to 11 years, the three-way distinction among the dialects in intelligibility was robust throughout this age range. An analysis of the subset of lifetime Midwestern listeners ($N=70, 74%$) revealed qualitatively similar results. Observed non-significant effects in the subset analysis can be attributed to reduced statistical power.

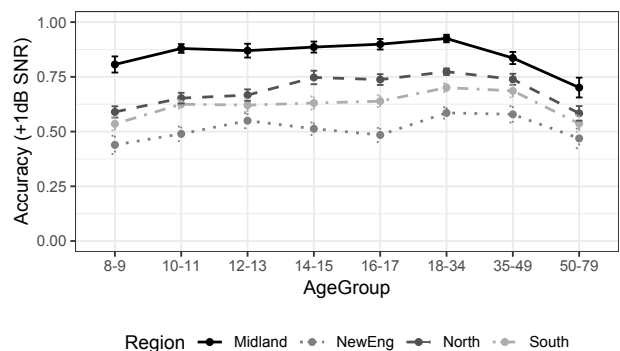
Figure 1: Mean proportion keywords correct for each talker dialect for each age group in the +6 dB SNR condition. Error bars show standard errors of subject means.



3.2. Harder +1 dB SNR condition

A summary of the keyword accuracy for each talker dialect for each age group in the harder +1 dB SNR condition is shown in Figure 2. The repeated measures ANOVA revealed a significant main effect of talker dialect ($F(3, 666)=313.57, p<.001$), a significant main effect of age group ($F(7, 222)=7.19, p<.001$), and a significant talker dialect x age group interaction ($F(21, 666)=1.99, p=.005$).

Figure 2: Mean proportion keywords correct for each talker dialect for each age group in the +1 dB SNR condition. Error bars show standard errors of subject means.



Post-hoc paired-sample t-tests with Bonferroni correction ($\alpha=.008$) on talker dialect revealed that

Midland talkers were significantly more intelligible than Northern talkers, who were significantly more intelligible than Southern talkers, who were significantly more intelligible than New England talkers. Thus, among these older children and adults, a significant overall difference in intelligibility between Northern and Southern talkers was observed that was not observed with the younger children. Post-hoc independent sample t-tests with Bonferroni correction ($\alpha=.002$) on age group revealed that 8-9 year olds and 50-79 year olds performed significantly more poorly than 18-49 year olds, and that 10-11 year olds performed significantly more poorly than 18-34 year olds. These results further confirm continued development in overall intelligibility accuracy among 8-11 year olds, but also suggest that performance reaches adult-like overall accuracy by age 12 years. Moreover, performance declines after age 50 years.

To explore the significant talker dialect \times age group interaction, post-hoc paired-sample t-tests with Bonferroni correction ($\alpha=.008$) were conducted within each age group to examine talker dialect differences in intelligibility. The results of these post-hoc tests were generally consistent with the overall pattern, with two exceptions. First, only 14-15 year olds and 18-34 year olds exhibited a significant intelligibility difference between the Northern and Southern talkers. This result suggests that younger children, for whom Northern and Southern talkers did not differ in intelligibility, exhibit qualitatively similar cross-dialect intelligibility to many older children, as well as to middle-aged and older adults. Second, the intelligibility of New England and Southern talkers did not differ for 8-9 year olds, 12-13 year olds, or 50-79 year olds. For the 8-9 year olds and, especially, for the 50-79 year olds, this lack of difference may reflect the compression of accuracy scores across dialects due to lower overall accuracy (see Figure 2). For the 12-13 year olds, this lack of difference suggests that development in cross-dialect intelligibility continues into the early teenage years, because children are not fully indistinguishable from young and middle-aged adults until 14-15 years. An analysis of the subset of lifetime Midwestern listeners ($N=142$, 62%) revealed qualitatively similar results to the full analysis. As in the analysis of the younger children's data, observed non-significant pairwise comparisons in the subset analysis can be attributed to reduced statistical power.

4. DISCUSSION

The Midwestern adults in the current study exhibited the most accurate intelligibility for Midland talkers, followed by Northern talkers, followed by Southern talkers, followed by Mid-Atlantic talkers. This

pattern is broadly consistent with the results of a similar study by Clopper and Bradlow [7] and confirms an overall intelligibility benefit for the most-standard Midland variety, as well as an intelligibility benefit for the more familiar (i.e., geographically closer) Northern and Southern varieties relative to the New England variety. The children showed a similar pattern of relative dialect intelligibility at age 4-5 years, but did not achieve adult-like intelligibility accuracy until age 12-15 years. Given the limited previous research examining dialect intelligibility in teenagers [cf. 1], these results provide an important missing piece of the developmental trajectory in this domain of sociolinguistic competence.

The results also reveal similarities between the developmental trajectory for regional dialect intelligibility and those for perceptual dialect classification and language attitudes. In all three perceptual domains, the developmental trajectory extends into adolescence, as suggested by Labov [18] for sociolinguistic competence in production. Moreover, the ages at which adult-like performance is observed are similar across perceptual domains: 10-13 years for language attitudes [10, 23], 12-15 years for intelligibility accuracy (the current study), and 14-17 years for dialect classification accuracy [16, 24, 32]. Although some of the studies exploring these three perceptual domains have been conducted with similar populations of talkers and listeners [i.e., 16, 23, 24], the participants differed across studies. Thus, to confirm the connections among these perceptual domains of sociolinguistic competence, a within-subjects study in which the same participants complete tasks in all three domains is necessary.

Finally, the results suggest a decline in dialect intelligibility performance among older adults. This decline is consistent with overall cognitive declines that begin in young adulthood [29], with declines in speech intelligibility that are observed in older adults, independent of documented hearing loss [12], and with declines in perceptual dialect classification performance [24]. The parallel declines in dialect classification and dialect intelligibility performance after age 50 years provide further evidence for the close cognitive connection between these perceptual domains of sociolinguistic competence.

5. ACKNOWLEDGMENTS

This work was supported by a seed grant from the Center for Cognitive and Brain Sciences at Ohio State University. We thank Elizabeth McCullough, Eryn Ahlers, Emily Behm, Lindsay Brown, Anna Coffman, Sara Gryboski, Liz Nugent, and Mikayla Perry for assistance with experimental design, data collection, and coding.

6. REFERENCES

- [1] Bent, T. 2018. Development of unfamiliar accent comprehension continues through adolescence. *J. Child Lang.* 45, 1400-1411.
- [2] Bent, T., Holt, R. F. 2018. Shhh... I need quiet! Children's understanding of American, British, and Japanese-accented English speakers. *Lang. Speech* 61, 657-673.
- [3] Best, C. T., Tyler, M. D., Gooding, T. N., Orlando, C. B., Quam, C. A. 2009. Development of phonological constancy: Toddlers' perception of native- and Jamaican-accented words. *Psych. Sci.* 20, 539-542.
- [4] Brysbaert, M., New, B. 2009. Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Res. Methods* 41, 977-990.
- [5] Byrd, D. 1994. Relations of sex and dialect to reduction. *Speech Communication* 15, 39-54.
- [6] Clay, M. M. 1976. The effect of two educated dialects on sentence repetition scores of five year old Scottish children. *Lang. Speech* 19, 244-250.
- [7] Clopper, C. G., Bradlow, A. R. 2008. Perception of dialect variation in noise: Intelligibility and classification. *Lang. Speech* 51, 175-198.
- [8] Clopper, C. G., Pisoni, D. B. 2006. Effects of region of origin and geographic mobility on perceptual dialect categorization. *Lang. Var. Change* 18, 193-221.
- [9] Creel, S. C. 2018. Accent detection and social cognition: Evidence of protracted learning. *Dev. Sci.* 21, e12524.
- [10] Cremona, C., Bates, E. 1977. The development of attitudes toward dialect in Italian children. *J. Psycholing. Res.* 6, 223-232.
- [11] Edwards, J., Gross, M., Chen, J., MacDonald, M. C., Kaplan, D., Brown, M., Seidenberg, M. S. 2014. Dialect awareness and lexical comprehension of mainstream American English in African American English-speaking children. *J. Speech Lang. Hear. Res.* 57, 1883-1895.
- [12] Ferguson, S. H., Jongman, A., Sereno, J. A., Keum, K. A. 2010. Intelligibility of foreign-accented speech for older adults with and without hearing loss. *J. Am. Acad. Audiology* 21, 153-162.
- [13] Fisher, W. M., Doddington, G. R., Goudie-Marshall, K. M. 1986. The DARPA speech recognition research database: Specifications and status. *Proc. DARPA Speech Recognition Workshop*, 93-99.
- [14] Jacewicz, E., Fox, R. A. 2012. The effects of cross-generational and cross-dialectal variation on vowel identification and classification. *J. Acoust. Soc. Am.* 131, 1413-1433.
- [15] Jacewicz, E., Fox, R. A. 2014. The effects of indexical and phonetic variation on vowel perception in typically developing 9- to 12-year-old children. *J. Speech Lang. Hear. Res.* 57, 389-405.
- [16] Jones, Z., Yan, Q., Wagner, L., Clopper, C. G. 2017. The development of dialect classification across the lifespan. *J. Phonetics* 60, 20-37.
- [17] Kinzler, K. D., Shutts, K., DeJesus, J., Spelke, E. S. 2009. Accent trumps race in guiding children's social preferences. *Social Cog.* 27, 623-634.
- [18] Labov, W. 1964. Stages in the acquisition of standard English. In: Shuy, R. (ed.), *Social Dialects and Language Learning*. Champaign, IL: National Council of Teachers of English, 77-104.
- [19] Labov, W. 1998. The three dialects of English. In: Linn, M. D. (ed.), *Handbook of Dialects and Language Variation*. San Diego: Academic Press, 39-81.
- [20] Labov, W., Ash, S. 1997. Understanding Birmingham. In: Bernstein, C., Nunnally, T., Sabino, R. (eds.), *Language Variety in the South Revisited*. Tuscaloosa, AL: University of Alabama Press, 508-573.
- [21] Labov, W., Ash, S., Boberg, C. 2006. *Atlas of North American English*. New York: Mouton de Gruyter.
- [22] Mason, H. M. 1946. Understandability of speech in noise as affected by region of origin of speaker and listener. *Speech Monographs* 13(2), 54-68.
- [23] McCullough, E. A., Clopper, C. G., Wagner, L. in press. The development of regional dialect locality judgments and implicit language attitudes across the life span. *Child Dev.*
- [24] McCullough, E. A., Clopper, C. G., Wagner, L. in press. Regional dialect perception across the lifespan: Identification and discrimination. *Lang. Speech.*
- [25] Mulak, K. E., Best, C. T., Tyler, M. D., Kitamura, C. 2013. Development of phonological constancy: 19-month olds, but not 15-month-olds, identify words in a non-native regional accent. *Child Dev.* 84, 2064-2078.
- [26] Nathan, L., Wells, B., Donlan, C. 1998. Children's comprehension of unfamiliar regional accents: A preliminary investigation. *J. Child Lang.* 25, 343-365.
- [27] Nelson, N. W., McRoskey, R. L. 1978. Comprehension of standard English at varied speaking rates by children whose major dialect is Black English. *J. Communication Disorders* 11, 37-50.
- [28] O'Connor, C., Gibbon, F. E. 2011. Familiarity of speaker accent on Irish children's performance on a sentence comprehension task. *J. Clinical Speech Lang. Studies* 18, 1-18.
- [29] Salthouse, T. A. 2009. When does age-related cognitive decline begin? *Neurobiology of Aging* 30, 507-514.
- [30] Smith, R., Holmes-Elliott, S., Pettinato, M., Knight, R.-A. 2014. Cross-accent intelligibility of speech in noise: Long-term familiarity and short-term familiarization. *Quarterly J. Exp. Psych.* 67, 590-608.
- [31] van Heugten, M., Krieger, D. R., Johnson, E. K. 2015. The developmental trajectory of toddlers' comprehension of unfamiliar regional accents. *Lang. Learning Dev.* 11, 41-65.
- [32] Williams, A., Garrett, P., Coupland, N. 1999. Dialect recognition. In: Preston, D. R. (ed.), *Handbook of Perceptual Dialectology*. Philadelphia: John Benjamins, 345-358.
- [33] Wright, R., Souza, P. 2012. Comparing identification of standardized and regionally valid vowels. *J. Speech Lang. Hear. Res.* 55, 182-193.