Journal of Memory and Language 99 (2018) 90–98

Contents lists available at ScienceDirect

Journal of Memory and Language

journal homepage: www.elsevier.com/locate/jml

The role of pitch pattern in Japanese 24-month-olds' word recognition

Hisako W. Yamamoto [a,*], Etsuko Haryu [b]

[a] Tokyo Woman's Christian University, Japan
[b] University of Tokyo, Japan

ARTICLE INFO

Article history:
Received 30 July 2016
Revision received 2 November 2017
Available online 24 November 2017

ABSTRACT

Previous research has demonstrated that Chinese-learning children use lexical pitch pattern to disambiguate words throughout development but English-learning children do not. To determine which linguistic properties lead children to retain such sensitivity, we focused on Japanese, a pitch accent language in which pitch pattern accompanies every word but plays a far weaker role in word discrimination than in Chinese. We observed Japanese-learning 24-month-olds' responses to a familiar word with an incorrect pitch pattern in a picture fixation task. The results show that children could identify the referent familiar object, although they needed more time to do so than when the word was presented with the correct pitch pattern. These results suggest that young Japanese children do not treat pitch pattern as a determinant of word meanings, although they can easily detect changes in pitch patterns. The findings are discussed in terms of the language properties that affect children's sensitivity to lexical pitch information.

Introduction

Children are sensitive to speech prosody from very early on. Neonates discriminate different passages (DeCasper & Spence, 1986) and languages (e.g., Byers-Heinlein, Burns, & Werker, 2010; Nazzi, Bertoncini, & Mehler, 1998), probably by attending to prosodic information. Preverbal infants infer a speaker's communicative intent based on speech prosody (Fernald, 1993). In the second half of their first year, infants begin to use prosodic information to discover boundaries of words and clauses in continuous speech (Curtin, Mintz, & Christiansen, 2005; Friederici, Friedrich, & Christophe, 2007; Höhle, Bijelijac-Babic, Herold, Weissenborn, & Nazzi, 2009; Jusczyk, Cutler, & Redanz, 1993; Jusczyk, Houston, & Newsome, 1999; Nazzi, Jusczyk, & Johnson, 2000).

Speech prosody can thus be used as a cue in word segmentation by preverbal infants. However, whether prosodic information can also be used as a cue in lexical disambiguation varies from language to language because languages vary in the extent to which they use prosodic information as relevant cues for word discrimination. For example, Chinese is a tone language, as shown in Table 1, in which every word is pronounced with its own tone, i.e., pitch pattern. In this language, pitch pattern plays a very important role in lexical disambiguation. For example, in Mandarin Chinese, the syllable *ma* with Tone 1 (high level pitch contour) means "mother," while *ma* with Tone 4 (falling pitch contour) means "scolding." As a result, the percentage of words discriminated only by tone, i.e., pitch pattern, is 71% in Mandarin Chinese (Shibata & Shibata, 1990).[1] On the other hand, English is a stress accent language. Every word has its own stress pattern, in which a stressed syllable is marked not only with higher pitch, but also with longer duration, stronger intensity, and clearer vowel quality (Fry, 1958; Klatt, 1976; Vance, 2008). Therefore, unlike Chinese, words are never discriminated only by pitch pattern in English. Sets of English words distinguished only by stress pattern constitute only 0.47% of the lexicon (Shibata & Shibata, 1990).

Such differences across languages appear to be reflected in children's developmental trajectories of lexical disambiguation using pitch information. English-learning children aged 24 months and over disregard pitch pattern in lexical disambiguation. That is, they are able to recognize a familiar/newly-learned word even when the word is aurally presented with a different pitch pattern from the one they have originally learned (Quam & Swingley, 2010; Singh, Tam, Chan, & Golinkoff, 2014; see also Mattock & Burnham,

[1] With the assistance of English and Mandarin-Chinese dictionaries, Shibata and Shibata (1990) calculated these values by dividing the number of words distinguished only by prosodic pattern (the position of the accented syllable) by the number of words containing the same segmental information (phonemes). In English, words with contrasting stress positions (such as *content*) were counted. In Chinese, words with the same phonemic syllables but different tones (such as *ma* with high level pitch contour, *ma* with falling pitch contour, and *ma* with rising pitch contour) were counted.

* Corresponding author at: Tokyo Woman's Christian University, 2-6-1 Zempukuji, Suginami-ku, Tokyo 167-8585, Japan.
E-mail address: sakohy@gmail.com (H.W. Yamamoto).

https://doi.org/10.1016/j.jml.2017.11.003
0749-596X/

Table 1
Linguistic properties of English, Chinese, and Japanese.

		English	Chinese	Japanese
Language type		Stress accent	Tone	Pitch accent
Word prosody		Stress pattern	Pitch pattern	Pitch pattern
The rate of words distinguished by prosody		0.47%	71.00%	13.57%
Children's use of lexical pitch pattern	18 m	yes	yes	?
	24 m	no	yes	

2006), although at 18 months their word recognition is hindered under the same situation (Singh et al., 2014). In contrast, Chinese-learning children aged not only 18 months but also 24 months and older have difficulty recognizing words presented with an unusual tone, i.e., an unusual pitch pattern (Singh & Chee, 2016; Singh, Goh, & Wewalaarachchi, 2015; Singh, Tan, & Wewalaarachchi, 2017; Singh et al., 2014; see also Mattock & Burnham, 2006; Mattock, Molnar, Polka, & Burnham, 2008; Quam & Swingley, 2014). Thus, the relevance of pitch pattern information to word discrimination appears to guide Chinese-learning children to persist in using lexical pitch pattern[2] for lexical disambiguation throughout development, while guiding English-learning children to disregard pitch pattern as a cue to lexical disambiguation.

However, before accepting this idea, we should consider another property of Chinese that may guide children to persist in using lexical pitch pattern for lexical disambiguation. In Chinese, all words are pronounced with their own conventional pitch patterns. This may be sufficient to explain why Chinese children continue to use lexical pitch patterns to disambiguate words throughout development. Thus, there are two possibilities for explaining why Chinese-learning children persist in using lexical pitch pattern to disambiguate words during development. The first is that Chinese children persist in using lexical pitch pattern because that information plays a critical role in word discrimination in Chinese. The second is that Chinese-learning children continue to use lexical pitch pattern because each word is always pronounced with its conventional pitch pattern.

Which possibility holds true, however, cannot be determined by investigating children learning Chinese, in which all words are pronounced with their own conventional pitch pattern and the pitch pattern plays a critical role in lexical disambiguation. To investigate this problem, it is worth examining children learning Japanese. As shown in Table 1, Japanese is a pitch accent language in which each word is always pronounced with its own conventional pitch pattern. For example, in Tokyo Japanese,[3] the word *neko* "cat" is always pronounced *NEko* (a high-low [HL] pitch pattern), and *inu* "dog" should be pronounced *iNU* (a low-high [LH] pitch pattern). However, according to Shibata and Shibata (1990)'s calculation based on a Japanese dictionary, the incidence of Japanese words distinguished only by pitch pattern is 13.57%, which is far lower than the 71% in Mandarin Chinese. Thus, Japanese is similar to Chinese in that each word is pronounced with its own conventional pitch pattern; however, the role played by pitch pattern in word discrimination is far weaker in Japanese than in Chinese.

Therefore, in the present study, we tested Japanese-learning 24-month-olds to determine which of the above two possibilities holds: That children persist in using lexical pitch pattern for word discrimination throughout development only when it plays a critical role in disambiguating words in that language, or that children continue to use lexical pitch pattern to disambiguate words if each word is always pronounced with its own conventional pitch pattern, whether or not the lexical pitch patterns play a critical role in disambiguating words in that language. If Japanese-learning 24-month-olds fail to identify a referent object when the noun is presented with an incorrect pitch pattern, we may conclude that the fact that each word is always accompanied by its own conventional pitch pattern guides children to remain attentive to lexical pitch pattern in word discrimination during language development. On the other hand, if Japanese-learning 24-month-olds are able to identify the referent of a familiar word even when the word is presented with an unusual lexical pitch pattern, we should conclude that children persist in using lexical pitch pattern to disambiguate words only when the information is a critical determinant of word meanings. Therefore, an investigation of Japanese-learning children's word recognition based on pitch patterns can clarify the relation between properties of languages and the development of pitch perception.

To investigate Japanese-learning 24-month-olds' treatment of pitch pattern, we used a picture fixation task. In that task, children listened to a label of a familiar object (target) while being shown a picture of the target and of a distractor object. In half of the trials, the label was pronounced with the correct pitch pattern (e.g., *NEko* for cat) and in the other half with an incorrect pitch pattern (e.g., *neKO*). If children use lexical pitch pattern as a critical cue to word discrimination, their fixation proportion to the target picture will decline to chance or below chance level when the word is presented with an incorrect pitch pattern. In contrast, if they do not regard pitch pattern as a determinant of word meanings, their fixation proportion to the target will still be above chance level, even when a familiar word is presented with an incorrect pitch pattern.

Experiment 1

Method

Participants

The participants comprised 22 Japanese-learning 24-month-olds (M = 24 months, 19 days; *range* = 23 months, 11 days to 25 months, 16 days; 11 were boys), all of whom lived in the Tokyo area. Data from an additional six children were excluded due to fussiness (n = 4) and experimenter errors (n = 2).

Stimulus materials

As targets, six familiar words, all disyllabic nouns, were selected from the Japanese MacArthur Communicative Development Inventory for 8- to 18-month-olds (Ogura & Watamaki, 2004): Three were HL pattern words, whose first and second syllables are pronounced with high and low pitch, respectively, while the other

[2] Here we use the term *lexical pitch pattern* to refer to lexical-level pitch patterns that are used for lexical disambiguation. In Chinese, each word has its own tone, that is, its own pitch pattern, and this information is used for lexical disambiguation. In contrast, English does not have lexical pitch pattern, although pitch patterns are used to mark prominence at the phrasal level. In Japanese, each word has its own pitch pattern, which plays some role in lexical disambiguation. Since we focus here on pitch patterns used in word discrimination, we use the term *lexical pitch pattern* to refer to both Chinese tone and Japanese pitch accent.

[3] Japanese dialects show some variation in their assignment of pitch patterns to words. In fact, there are some accentless dialects (e.g., a dialect spoken in Kumamoto) in which every word is pronounced with a flat pitch pattern and words are not discriminated only by pitch pattern (Shibatani, 1990). In these dialects, pitch pattern is not used for word discrimination. However, dialects that assign pitch pattern to every word are spoken in more areas in Japan than accentless dialects. Therefore, we focused here on Tokyo Japanese as a typical pitch accent language.