Categorical speaker-memory in native and non-native listeners

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While listeners associate speech pattern signals with specific speakers to remember what was said, less is known about memory for speakers and how listener proficiency affects such memory. In a recognition memory task, we tested non-native and native participants' ability to associate objects of prototypical colors (e.g., red lobster, green frog) with speakers. One of two speakers referred to a subset of 30 items (instructions: “Click on the ...”), presented in either a categorical (one color per speaker) or random (mixed speaker-color) condition. While native listeners showed significant improvement in speaker recognition in the categorical condition, non-native listeners did not.

1 Introduction

Listeners can learn to associate patterns in the speech signal with specific speakers (e.g., higher-pitched voices for female speakers) and use this information for understanding spoken input (e.g., Lattner & Friederici, 2003). These learned associations can furthermore help to memorize what has been said (e.g., Clopper, Tamati & Pierrehumbert, 2016), also in cases when associations are learned between objects and speakers who refer to them rather than between the speech signal and speakers (e.g., McKinley, Brown-Schmidt, & Benjamin, 2017). In addition to information about what has been said, information about who has said it is also available for storage, but less is known about whether learned associations also help to memorize who the speaker was. Remembering both what has been said as well as who said it can help in the long run to build general knowledge about stereotypical correspondences between objects and speakers (e.g., small children and toys). Such information may be particularly critical for listeners with less social experience in a particular speech environment, such as non-native speakers, as making and remembering these connections may help to bridge social or cultural gaps. However, less proficient listeners may be at a disadvantage as they need to deal with the additional cognitive demands of L2 processing (e.g., Morishima, 2013) and may have more difficulty memorizing categorically associated information (e.g., Waring, 1997).

The current study investigates how this process of associating speakers with object categories impacts memory for speakers and how this relationship varies as a function of participants’ language proficiency. To our knowledge, there are no current studies that have examined this type of speaker-item-based relationship for non-native listeners; though, there is some research for native listeners. Horton and Slaten (2012), for instance, investigated how newly learned speaker-item associations are used online to predict linguistic behavior in eye-tracking. Native participants first listened to speakers referring to various tangram objects, and subsequently a speaker’s voice predicted participants’ looks to objects that had previously been referred to by the speaker. McKinley and colleagues (2017) used a referential communication task in which participants first had to label pictures of objects before they were asked inter alia who had used the label. Note that neither in Horton and Slaten (2012) nor in McKinley et al. (2017) was there an ascertainable pattern between speakers and objects. Considering talker-recognition studies, however, there is evidence that listeners are less able to identify talkers in their L2 compared to their L1 (e.g., Bregman & Creel, 2014), even when memory for the speaker is in focus, as is not the case in the current study.

The current study incorporates the aspect of a categorical pattern, particularly the prototypical color associated with an item (e.g., frogs are prototypically green), such that speakers either showed a pattern of referring only to objects of one color or referred to objects of several colors (no pattern). While there is little research following this schema,

research on categorical memory suggests that semantic patterns, for example, can aid memory for words in lists (e.g., Poirier & Saint-Aubin, 1995), and even that patterns need not be part of a conscious memory strategy to contribute to processing (see e.g., Schacter et al., 2004). For non-native participants, the influence of such categorical information is less clear, but such categories may even hinder memory performance (e.g., Waring, 1997, but see Hoshino, 2010).

2 Experiment

Using a recognition memory task, the ability of non-native and native participants to associate objects that have prototypical colors with speakers was tested. Based on the processing research discussed above, we expected that native participants will show an increase in memory performance when color patterns are associated categorically with specific speakers in comparison to a random association. While predictions for non-native participants were less clear, we expected that this increase may be limited if present at all.

2.1 Methods

2.1.1 Participants

Sixty native speakers of American English (18-35, mean: 26.97, 32 male, 27 female) and 62 highly proficient non-native speakers (German L1, 18-49, mean:25.26, 43 female, 18 male) participated in the experiment online via Gorilla Experiment Builder (Anwyl-Irvine et al., 2020).

2.1.2 Materials

Experimental items were 30 pictures of objects that prototypically belong to the perceptual categories of either red or green objects (e.g., red lobster, green frog). Strong associations between the objects and their prototypical color were confirmed via association strength norms from the Small World of Words database (Deyne et al., 2019). All pictures were shown in black and white during the experiment. Two native speakers of American English (male, 31 and female, 33) were recorded referring to all objects with the carrier phrase “Click on the …”.

2.1.3 Procedure

In an association phase, two objects were shown on the screen in a trial, and a recording from either the male or female speaker instructed participants to click on one of the objects. In a categorical condition, all objects referred to by one speaker had the same prototypical color (i.e., the female speaker only referred to green objects and the male speaker only to red objects, or vice versa), and in a random condition, both speakers referred to objects of both colors arbitrarily. The 30 objects were referred to twice by the same speaker across two blocks.

In the testing phase, pictures of the objects were shown individually, and participants had to indicate whether the male or female speaker had referred to the object previously. All participants ended the experiment with a short questionnaire, including some language background information and a question about whether they had noticed a pattern in the speakers’ referential expressions; non-native participants additionally completed the LexTale task (Lemhöfer, 2012) to assess their proficiency in English.

2.2 Analysis and Results

Linear mixed-effects regression models were performed with *correctness* (1 = correct, 0 = incorrect) as the dependent variable and *category* (categorical and random, coded as 0.5 and -0.5, respectively) and *language* (native, non-native, coded as 0.5, and -0.5, respectively) as fixed effects. *Subjects* and *Items* were also included as random factors with random slopes, where justified. Other effects considered in model-building were *trial order*, *speaker gender*, *item color*, *participant gender*, *participant age*, and indicated *use of headphones*. All factors were numerically centered around zero, and binary factors sum-

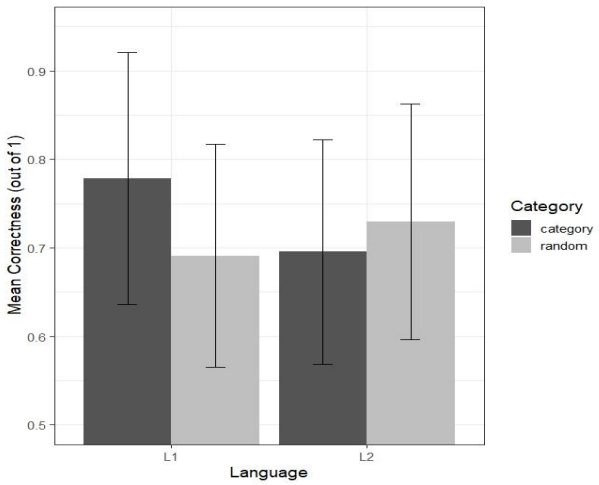
coded as above. One participant did not follow instructions and four participants performed very poorly on the task and were removed from the data analysis, leaving 117 participants in the final analysis (58 L1, 59 L2).

Table 1

Fixed Effects	***ß***	**SE**	***t***	**Pr(>|*t*|)**	
(Intercept)	0.724	0.018	41.017	<2e-16	***
Category	0.027	0.030	0.904	0.3684	
Language	0.022	0.028	0.801	0.4248	
Category x Language	0.122	0.055	2.201	0.0298	*
Random Effects	**Variance**	***SD***	**Correlation**		
Subject	0.016264	0.12753			
Item	0.003626	0.06022			
Category	0.003296	0.05741	-0.11		

The results are summarized in Table 1, including only the factors that improved model fit. A significant interaction between *language* and *category* suggests that recognition memory for speaker-item associations was impacted differently by perceptual color patterns for native and non-native participants. The mean correctness by *language* and *category* is displayed in Figure 1 (whiskers display standard error of the mean).

Figure 1



Further analyses of each language group individually confirm that native participants show improved retrieval of speaker-item associations in the categorical condition significantly (*ß*= .087, *t*= 2.167, *p*<.05) whereas non-native participants did not show an effect (*ß*= -.040, *t*= -1.051, *p*= .299).

3 Conclusion

This study found differences in retrieval between native and non-native participants for speaker-item associations. Specifically, category-based speaker preferences influenced native participants' memory, while memory of highly proficient non-native participants was not influenced by that information. The questionnaire also suggested that this memory advantage was not dependent on consciously noticing speaker preferences, as participants had not reliably identified the perceptual pattern in the categorical condition.

The results were in line with expectations that the processing abilities of native speakers to use referential information in online processing (e.g., Horton & Slaten, 2012; MicKinley et al., 2017) translates to benefits for memory. The lack of memory benefit in non-native listeners

is in line with both decreased abilities in talker recognition (e.g., Bregman & Creel, 2014) as well as the possibility that fewer free processing resources may prevent L2 listeners from taking advantage of the same information (e.g., Morishima, 2013; Sorace & Filiaci, 2006). Thus, while a steady category preference can improve native participants' speaker memory, the same is not true for non-native participants.

References

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*, 388–407. https://doi.org/10.3758/s13428-019-01237-x

Bregman M.R., Creel, S.C. (2014). Gradient language dominance affects talker learning. *Cognition*, 130(1), 85-95. https://doi.org/10.1016/j.cognition.2013.09.010

Clopper, C. G., Tamati, T. N., & Pierrehumbert, J. B. (2016). Variation in the strength of lexical encoding across dialects. *Journal of Phonetics*, 58, 87-103. https://doi.org/10.1016/j.wocn.2016.06.002

Deyne, S. de, Navarro, D. J., Perfors, A., Brysbaert, M., & Storms, G. (2019). The "Small World of Words" English word association norms for over 12,000 cue words. *Behavior Research Methods*, *51*, 987–1006. https://doi.org/10.3758/s13428-018-1115-7

Horton, W. S., & Slaten, D. G. (2012). Anticipating who will say what: The influence of speaker-specific memory associations on reference resolution. *Memory & Cognition*, *40*, 113–126. https://doi.org/10.3758/s13421-011-0135-7

Hoshino, Y. (2010). The Categorical Facilitation Effects on L2 Vocabulary Learning in a Classroom Setting. *RELC Journal*, *41*(3), 301–312. https://doi.org/10.1177/0033688210380558

Lattner, S., & Friederici, A. D. (2003). Talker's voice and gender stereotype in human auditory sentence processing–evidence from event-related brain potentials. *Neuroscience Letters*, 339(3), 191-194. https://doi.org/10.1016/S0304-3940(03)00027-2

Lemhöfer, K., & Broersma, M. (2012). Introducing LexTALE: A quick and valid lexical test for advanced learners of English. *Behavior Research Methods*, 44(2), 325-343. https://doi.org/10.3758/s13428-011-0146-0

McKinley, G. L., Brown-Schmidt, S., & Benjamin, A. S. (2017). Memory for conversation and the development of common ground. *Memory & Cognition*, 45(8), 1281-1294. https://doi.org/10.3758/s13421-017-0730-3

Morishima, Y. (2013). Allocation of limited cognitive resources during text comprehension in a second language. *Discourse Processes*, 50(8), 577-597, https://doi.org/10.1080/0163853X.2013.846964

Poirier, M., & Saint-Aubin, J. (1995). Memory for related and unrelated words: Further evidence on the influence of semantic factors in immediate serial recall. *QJEP*, *48*(2), 384–404. https://doi.org/10.1080/14640749508401396

Schacter, D. L., Dobbins, I. G., & Schnyer, D. M. (2004). Specificity of priming: A cognitive neuroscience perspective. *Nature Reviews Neuroscience*, *5*(11), 853–862. https://doi.org/10.1038/nrn1534

Sorace A, Filiaci F. Anaphora resolution in near-native speakers of Italian. Second Language Research. 2006;22(3):339-368. https://doi.org/10.1191/0267658306sr271oa

Waring, R. (1997). The negative effects of learning words in semantic sets: A replication. *System*, 25, 261-274. https://doi.org/10.1016/S0346-251X(97)00013-4