frontiers | Frontiers in Language Sciences

TYPE Original Research
PUBLISHED 10 January 2024
DOI 10.3389/flang.2023.1296945

OPEN ACCESS

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RECEIVED 19 September 2023
ACCEPTED 18 December 2023
PUBLISHED 10 January 2024

CITATION
Beck SD and Weber A (2024) Who said it? Native and non-native listeners' source memory for object-speaker associations. *Front. Lang. Sci.* 2:1296945. doi: 10.3389/flang.2023.1296945

Who said it? Native and non-native listeners' source memory for object-speaker associations

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Memory for who said what can help native and non-native listeners identify critical information for use in conversations. In two experiments, source memory for object-speaker associations was tested for listeners varying in language proficiency. Native and non-native participants of English first heard speakers name objects with prototypical color (e.g., broccoli) before they had to indicate who had previously named each object. Speakers either consistently named objects of one color, or they randomly named objects of different colors. While both listener groups associated objects with speakers successfully, in Experiment 1, with black and white images, native listeners showed an advantage in source memory in the color consistent condition over the random condition, while non-native listeners had no such advantage. The finding for non-native listeners was replicated in Experiment 2 with color images. The results confirm the role of source memory representations in communication, but also suggest that encoding object-speaker association in L2 may be less sensitive to consistent patterns in the input.

KEYWORDS

object-speaker associations, source memory, color consistency, common ground, non-native listeners

1 Introduction

Source memory involves recalling not only a particular piece of information but also, for example, where, when, and from whom this information was obtained. The ability to remember the source of information is critical for many aspects of communication (for a review see, Mitchell and Johnson, 2000). For example, if interlocutors remember what they hear from different people, they can assume common ground and continue a conversation where it left off (Lewis, 1979; Clark, 1996). Also, knowing the source of information allows listeners to make more informed judgments about the information's credibility (e.g., Henkel and Mattson, 2011). And finally, knowing what speakers have talked about previously can even help listeners predict what speakers will talk about next (e.g., Horton and Slaten, 2012). In the present study, we focus on how well native (L1) and non-native (L2) listeners can remember who the speaker was, and if this source memory can be improved by consistent patterns in what a speaker refers to.

It is widely acknowledged that we consider whom we are talking to and that we tend to mirror certain words and phrases used by our conversational partners. This so-called lexical entrainment for labeling objects (e.g., Garrod and Anderson, 1987) as well as later adjustments of such labels for new conversational partners (e.g., Brennan and Clark, 1996) has been found in conversations involving native interlocutors and non-native interlocutors alike (e.g., Bortfeld and Brennan, 1997; Zhang and Nicol, 2022),

suggesting that both groups of speakers adapt actively to contextual information about their conversational partners. Horton and Gerrig (2005a) argued that whether an utterance reflects partner-specific considerations mainly depends on the availability of suitable memory representations as input for the production process.

Partner-specific information has also been shown to help native listeners with the interpretation of what is being said. For example, Horton and Slaten (2012) investigated how newly learned associations between objects and speakers are used online to prompt expectations about upcoming referents. Native participants first listened to speakers referring to various tangram objects. In one experimental condition, one speaker referred to a tangram of a cat sitting up, while another referred to a tangram of a cat drinking milk. Subsequently, individual speakers' voices predicted participants' looks to objects that had previously been referred to by those speakers. In terms of memory, native listeners have also been found to encode source information along with item information. McKinley et al. (2017), for example, used a referential communication task in which pictures of objects were described by different participants acting as conversational partners before they had to remember who had referred to them. Native participants were indeed able to reliably denote speakers based on individual objects.

To our knowledge, only one study so far examined source memory (though not speaker memory) for non-native participants. In three source memory experiments, Francis et al. (2019) first presented Spanish-English bilinguals and monolingual English speakers with low and high frequency words before they had to indicate the source associated with each word. Source memory was defined in Experiment 1 as visuo-spatial context (i.e., on which side of the screen a word was presented), in Experiment 2 as temporal context (i.e., in which list a word was presented), and in Experiment 3 as modality context (i.e., in which modality a word was presented). Overall, the finding was better source memory for bilinguals than monolinguals with bilinguals also exhibiting a stable memory advantage for low frequency words. Based on their results, the authors proposed the associative strength theory in which strengths of various types of memory associations may depend on language proficiency.

In none of the above studies, however, were the item-source associations marked by any patterns, such as a consistency in the type or size of objects for individual speakers. For example, when one speaker consistently talks about salty food while another speaker only talks about sweets, these preferences for categories of food could help listeners to remember who said what. Such categorical preferences can even be learned implicitly by inducing over exemplars (Hahn et al., 2005), and for native participants, these patterns need not be part of a conscious memory strategy to contribute to processing (see e.g., Schacter et al., 2004). Notably, though, the influence of such categorical information for non-native participants is not clear, but it may even hinder memory performance, at least for word learning. For example, while Waring (1997) found a negative effect of semantic overlap on word learning for non-native participants, Hoshino (2010) found increased performance for words belonging to a category.

For source memory, one would generally expect that the stronger the association between item and source is, the easier it is to retrieve the source (see e.g., Guo et al., 2021) with the possibility that association strength varies with language proficiency. Some first evidence for stable patterns strengthening object-speaker associations for native participants comes from a study by Horton and Gerrig (2005b) on language production. The authors looked at reference production following experiences in a card matching task that manipulated whether speakers came to be consistently associated with one category of cards (e.g., only cards with birds) or were associated randomly with different categories of cards. When speakers had to describe previous stimuli to listeners in later rounds, they were more efficient in choosing the appropriate stimuli description when they had previously been in the category consistent condition.

The current study is the first to test source memory in object-speaker associations that include a stable pattern for native and non-native participants. A stable pattern was achieved by speakers consistently referring only to objects of one color (i.e., one speaker referring only to objects that are prototypically green, another speaker referring only to objects that are prototypically red). Prototypical object color has previously been shown to influence language processing in an eye-tracking study. Huettig and Altmann (2011), for example, had participants listen to sentences with references to objects with color competitors (e.g., frog and spinach are both prototypically green) and found that stored prototypical color information influenced language-mediated eye-movements, both when the color of objects was shown and when objects were presented in black and white.

While the literature presented here suggests that both native and non-native listeners can adapt to speaker information during communication, it is unclear whether either participant group encodes consistent speaker preferences to memory for use in a global context of speaker-related information. First, by looking at listeners' memory for who said what based on categorical information, we will extend what we know about patterns in object-speaker associations from language production studies (Horton and Gerrig, 2005b) to the realm of listening. Furthermore, by comparing native and non-native listeners' performance, we take the first steps toward investigating how memory for object-speaker associations might differ for the two groups.

We know that source memory can be weakened when attentional resources are impeded (e.g., Mulligan, 2004), and language processing in a non-native language is generally more challenging than in a person's native language (e.g., Cutler, 2012). L2 processing is less automatic, demanding more mental strain; vocabulary is less familiar, requiring more attention; and processing speed is slower, consuming more attentional resources. All these factors may impede cognitive resources (e.g., Sorace and Filiaci, 2006), making it harder for non-native listeners to divert their attention to other tasks such as noticing or encoding a consistent pattern in object-speaker associations. Note however, that following Francis et al. (2019), lower word frequency of lexical items in L2 might also facilitate the encoding of source information, as it was found at least for visuo-spatial, temporal, and modality contexts.

In sum, differences in native and non-native listeners' performance may give insight into both how L2 listeners

build speaker contexts but also into more general L2 memory mechanisms during communication.

2 Experiment 1

With a source memory task, the ability of native and non-native listeners to associate objects with speakers was tested. Specifically, we investigated objects of prototypical colors (e.g., green broccoli and red tomato) and whether listeners' source memory for speakers increased when speakers consistently referred to objects of one color rather than randomly referred to objects of different colors. We expected that native listeners will show a higher memory performance when speakers were consistently associated with objects of one color in comparison to a random color association, in line with the advantage for consistent association patterns in speaking (Horton and Gerrig, 2005b). For non-native listeners, we expected that the challenge of listening to an L2, will probably reduce participants' ability to additionally encode consistent patterns in object-speaker associations.

2.1 Methods

The experiment was built using Gorilla Experiment Builder (www.gorilla.sc) and designed and run as an online experiment (Anwyl-Irvine et al., 2020). The main part of the experiment consisted of a listening task (the association phase) followed by a source memory task (the testing phase).

2.1.1 Participants

Sixty native speakers of American English (age between 18 and 35, mean: 26.97, 27 females, 32 males), recruited via Prolific, and 62 highly proficient non-native speakers (German L1, age between 18 and 49, mean: 25.26, 43 females, 18 males), recruited via the University of Tübingen, participated in the online experiment. All participants had normal or corrected-to-normal vision and were not color blind. Non-native participants had a self-rated proficiency of 5.3 on a scale from 1 "poor" to 7 "native-like" (averaged across speaking, writing, reading, and listening). Participants were paid according to the standards of the University of Tübingen either via the Prolific system or via a gift card lottery. Recruitment, payment, and procedure followed the standard practices of ethical consent according to the *LingTüLab*'s approval from the DFG (German Research Foundation).

2.1.2 Materials

Experimental items were black and white versions of 30 photographic color images of objects that prototypically belong to the color categories of either red or green objects. Half of the objects were prototypically green (e.g., broccoli) and half were prototypically red (e.g., tomato). Strong association between objects and their prototypical color was confirmed via English association strength norms from the Small World of Words database (De Deyne et al., 2019) using backward associations from the colors red and green. These associations were confirmed by two native speakers to apply in German as well. The selected objects were common to every-day life and were not associated with a specific gender (e.g., lipstick with women) or a specific culture or geographic area (e.g., red barns in the USA). All images were converted to black and white using standard Windows 10 imaging software. Presenting images in black and white made color conceptually available as an aspect of speaker preferences without being perceptible. This choice was motived by findings of Huettig and Altmann (2011), which showed that black and white images of objects still allow for conceptual color information to be retrieved without color being shown.

For each of the 30 experimental items, instructions to click on the object were recorded by two native speakers of American English (male, 31 and female, 33). The two speakers were recorded in the recording studio of the *LingTüLab* of the University of Tübingen. All objects were referred to with the simple carrier phrase "click on the (OBJECT)."

2.1.3 Procedure

The experiment was conducted in two phases, an association phase and a testing phase (followed by a short language background questionnaire and an experiment debriefing). Participants first completed a short LexTale task, to assess language proficiency (Lemhöfer and Broersma, 2012). Then, participants were given the instructions that they would participate in a listening task, in which they would see two images and be instructed to click on one of the images, followed by a question task, that may ask about information presented in the listening phase.

2.1.3.1 Association phase

In each trial of the association phase, black and white images of a green and a red object were shown next to each other on the screen, and a speaker instructed participants to click on one of the objects while the other object remained unnamed. An example screen can be seen in Figure 1. Following a click on the target object, the next trial screen appeared. As screen size varied for at-home participants, images were presented as squares scaled to be 1/3 of the full screen in width at 100% resolution and separated by 10% of the screen's width. When the unnamed object became a target object in a subsequent trial, it was paired with a different object. Position of target objects (i.e., left or right screen side) was counterbalanced across trials, as was speaker identity (i.e., male or female). Each speaker referred to 15 of the 30 objects. In a color consistent condition, all objects referred to by one speaker had the same prototypical color (i.e., the female speaker referred to all green objects and the male speaker to all red objects, or vice versa), and in a pseudo-random color condition, both speakers referred to objects of both colors arbitrarily but equally often. To increase exposure to object-speaker associations, the association phase was immediately repeated in a second round that was identical to the first round, such that overall, participants were exposed twice to the 30 object-speaker associations during the association phase.

2.1.3.2 Testing phase

In the testing phase, black and white images of the objects were shown individually, and participants indicated which speaker had referred to the object previously via a mouse click with the

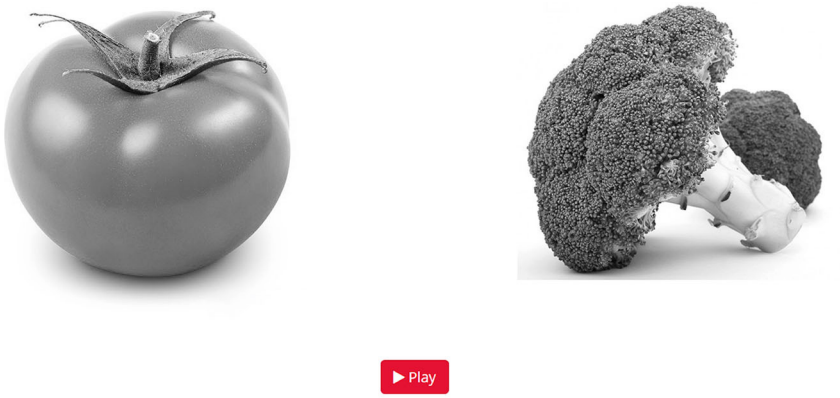

FIGURE 1
Example trial screen showing a tomato and a broccoli in Experiment 1. Images sourced from Free Range Stock, www.freerangestock.com.

TABLE 1 **Model summary for experiment 1.**

Fixed effects	ß	SE	*t*	Pr(>|*t*|)	
(Intercept)	1.10484	0.09797	11.277	<0.001	***
Color consistency	0.18083	0.16431	1.101	0.2711	
Language	0.14481	0.15416	0.939	0.3476	
Color consistency × language	0.72357	0.30832	2.347	0.0189	*
Random effects	**Variance**	***SD***	**Correlation**		
Participants	0.49967	0.7069			
Items	0.10925	0.3305			
Color consistency	0.09594	0.3097	0.01		

$^{*}p < 0.05$, $^{***}p < 0.001$.

options "male speaker," "female speaker," and "I'm not sure". All participants saw the objects in a randomized order and needed to make a selection to continue. The experiment ended 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 were additionally asked to assess their proficiency in English.

2.2 Results

R (R Core Team, 2022) was used to conduct the statistical analyses with the package lme4 (Bates et al., 2015). Native and non-native participants performed almost perfectly in the association phase (99.0% and 99.5% correct, respectively), suggesting an understanding of the task and vocabulary for both groups. Responses from the testing phase were used in logistic mixed-effects models (glmer) with *Correctness* (1 = correct, 0 = incorrect) as the dependent variable and *Color Consistency* (consistent and random, coded as 0.5 and −0.5, respectively) and *Language* (native and non-native, coded as 0.5, and −0.5, respectively) as fixed effects. *Participants* and *Items* were also included as random factors with random slopes, where justified. All factors were numerically centered around zero, and binary factors sum-coded as above.[1] One participant did not follow instructions and four participants performed very poorly on the source memory task (correctness < 40%) and were removed from the data analysis, leaving 117 participants in the final analysis (58 L1, 59 L2).

Participants in both language groups were successful in the task of the testing phase, performing well above chance with no overall difference based on language background of the participants (L1 73.33%, L2 71.19% correct). The results are summarized in Table 1, including only the factors that improved model fit. *P*-values were obtained using a Wald *z*-distribution approximation and were confirmed by parametric bootstrap using the afex package (Singmann et al., 2023). A significant interaction between *Language* and *Color Consistency* suggests that source memory for object-speaker associations was impacted differently by conceptual color consistency for native and non-native participants. The *Color Consistency* by *Language* interaction is displayed in Figure 2.

Further analyses of each language group individually confirmed that native participants had improved retrieval of object-speaker

1 *Trial Order* was also initially included on an exploratory basis. However, it neither improved model fit nor reached significance, it was not included in the final model ($\chi^2 = 1.7251$, $p = 0.189$).

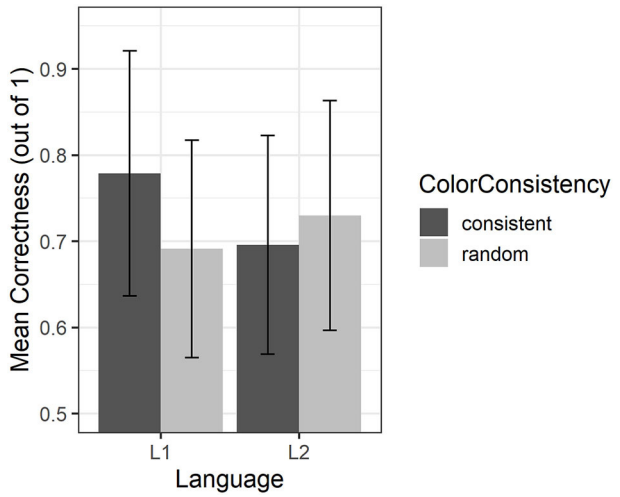

FIGURE 2
Mean correct responses by color consistency of speakers and language group of participants in Experiment 1. Bars represent the standard error of the mean.

associations in the color consistent condition significantly in comparison to the random color condition ($ß = 0.515$, $t = 2.284$, $p = 0.0224$) whereas non-native participants did not show an effect ($ß = -0.163$, $t = -0.769$, $p = 0.442$).

2.3 Preliminary discussion

Experiment 1 found differences in memory between native and non-native participants for object-speaker associations. Consistent speaker preferences grounded in prototypical object color influenced native participants' source memory, while source memory of highly proficient non-native participants was not influenced by that information. That is, while native participants remembered better who the speaker was when the speaker had exclusively referred to objects of one color, non-native participants did not show this source memory advantage. The questionnaire also suggested that this memory advantage was not dependent on consciously noticing speaker preferences, as participants had not reliably identified the stable pattern in the color consistent condition. Indeed, only two participants had correctly noticed it (1 L1, 1 L2 participant). Thus, while a steady color preference can improve native participants' source memory, even when it is neither explicitly in focus nor even consciously noticed, the same does not appear to be true for non-native participants.

While the objects in Experiment 1 comprised color prototypicality in English and German, these objects were not displayed in their natural colors but in black and white. It is possible that native participants, but not non-native participants, had readily accessed and encoded conceptual color information in Experiment 1. Maybe fewer free processing resources in a second language (e.g., Sorace and Filiaci, 2006) forced non-native participants to be more selective of their attention during listening, and in black and white images the functional aspect of color was not salient enough for non-native participants to be taken into consideration for global context-building about speakers. Alternatively, non-native participants possibly had accessed conceptual color information, but did not have sufficient processing resources available to encode this information in memory.

Whichever explanation is true, this begs the question: if color is displayed during such a task, will non-native participants then use color information in such a way that source memory is improved in the color consistent condition? To answer this question, Experiment 2 replicates Experiment 1 for non-native participants using colored instead of black and white images of objects.

3 Experiment 2

A second experiment was conducted to determine whether showing the objects in color would allow non-native participants to use color consistency in object-speaker associations to improve source memory.

3.1 Method

Experiment 2 was identical to Experiment 1 in all aspects of design and implementation, but the photographic images of objects were shown in their original colors.

3.1.1 Participants

Forty-two highly proficient non-native speakers of English (German L1, age between 18 and 37, mean: 22.83, 32 female, 10 male), recruited at the University of Tübingen, participated in the online experiment. As in Experiment 1, non-native participants reported high proficiency in English with a self- rating of 5.9, averaged across speaking, writing, reading, and listening, on a scale from 1 "poor" to 7 "native-like." Participants were paid via gift card lottery according to the payment standards at the University of Tübingen.

3.1.2 Materials

All materials were identical to Experiment 1, except the photographic images of the objects were shown in their original colors (i.e., natural shades of red or green). See Figure 3 for an example.

3.1.3 Procedure

The experimental procedure was identical to Experiment 1. The only difference was that the association phase included color images.

3.2 Results

R (R Core Team, 2022) was again used to conduct the statistical analyses. As in Experiment 1, participants performed almost perfectly in the association phase (average 99.6% correct), again

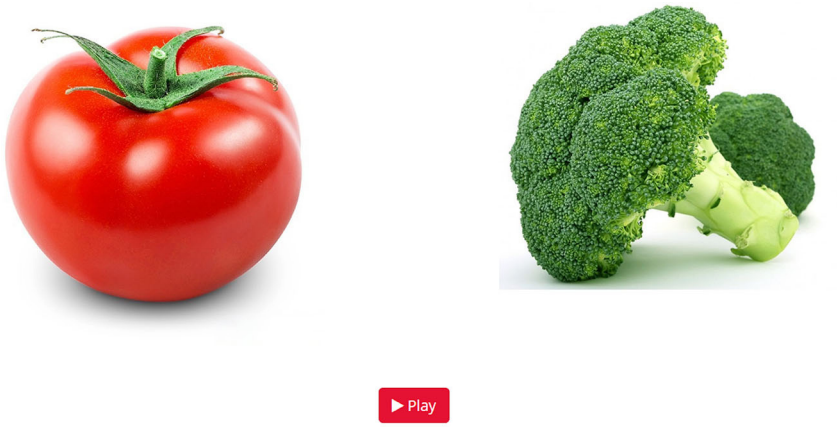

FIGURE 3
Example trial screen showing a tomato and a broccoli in Experiment 2. Images sourced from Free Range Stock, www.freerangestock.com.

suggesting an understanding of the task and vocabulary. Responses of the testing phase were used in logistic mixed-effect models using lme4 (Bates et al., 2015) and glmer with *Correctness* (1 = correct, 0 = incorrect) as the dependent variable and *Color Consistency* (consistent and random, coded as 0.5 and −0.5, respectively) as a fixed effect. *Participants* and *Items* were also included as random factors with random slopes, where justified. All factors were numerically centered around zero, and binary factors were sum-coded as above.[2] Four participants did not meet the criterion for native speakers of German, and two participants performed poorly on the task (correctness < 40%). These participants were removed from the data analysis, leaving 36 participants in the final analysis.

The results of the final model are shown in Table 2, again including only factors which contributed to a better model fit. *P*-values were also obtained and confirmed in the same manner as in Experiment 1. Figure 4 displays the overall performance by *Color Consistency*. As can be seen, the performance of the non-native participants in Experiment 2 closely resembles the performance of the non-native participants in Experiment 1. Average correct responses in the consistent color condition were 66.1% and 70.6% in the random color condition (Experiment 1: 69.6% and 73.0% respectively) and were well above chance. As in Experiment 1, *Color Consistency* did not significantly improve participants' memory for speaker-object associations. That is, non-native participants remembered equally well who had referred to an object during the association phase when speakers had consistently referred to objects of one color and when they had randomly referred to objects with different colors.

In an exploratory analysis, the factors that did improve model fit, however, were the average self-rated English *Proficiency*, *Participant Age*, and significantly, *Speaker*. While *Proficiency* only aided model fit and did not reach more than marginal significance, it suggests that there may be a benefit of participants' English L2 abilities in overall performance. Though, this marginal trend was not present in Experiment 1 in the subset L2 data ($\beta = 0.153$, $t = -1.452$, $p = 0.146$), and a greater range of proficiencies may be necessary to explore this effect further (a high mean of 75.4/100, $SD = 12.27$ on the LexTale). Additionally, the effect of participants' age, suggesting that older participants may be overall better at the task than younger participants. was not found in Experiment 1, and the finding in Experiment 2 may also be due to a rather limited age range in participants. As for the significant effect of *Speaker* ($\beta = -0.367$, $t = -2.692$, $p = 0.007$), the source was overall remembered better when the female speaker had referred to objects than when the male speaker had referred to objects in Experiment 2. As both male and female speakers had referred to all objects in all conditions across lists, this effect does not appear to be item-based. Notably, though, most participants in Experiment 2 were female (78% of participants in the final analysis). There are findings that suggest that similarity in talker and listeners' voice properties or even simply a preference for female speakers may improve listening (Schuerman et al., 2015, 2019), and such a preference may have given a small benefit for the memory of female-spoken object-speaker associations in Experiment 2. However, Horton and Slaten (2012) also used differing speaker genders and found that this factor was not critical for overall performance. As this finding is also only present in Experiment 2, more research would be needed to clarify the role of speaker and participant gender in source memory.

4 General discussion

Overall, the two experiments presented here suggest that non-native listeners are less sensitive than native listeners to consistent patterns in speaker preferences when encoding speaker-item associations, particularly when the pattern is based on prototypical color features. While native listeners were sensitive to color consistency already when color was presented only as a conceptual category (Experiment 1), non-native listeners did not benefit from this categorical information, even when color information was added to the presentation (Experiment 2). That is, non-native listeners remembered equally well who the speaker was

2 *Trial Order* was also initially included on an exploratory basis, as in Experiment 1. However, it neither improved model fit nor reached significance, it was not included in the final model ($\chi^2 = 0.7446$, $p = 0.388$).

TABLE 2 Model summary for experiment 2.

Fixed effects	ß	SE	*t*	Pr(>|*t*|)	
(Intercept)	0.8741	0.1289	6.781	<0.0001	***
Color consistency	−0.1797	0.2605	−0.69	0.49025	
Proficiency	0.2515	0.1298	1.937	0.05274	
Participant age	0.2635	0.1327	1.986	0.04704	*
Speaker	−0.3674	0.1365	−2.692	0.00711	**
Random effects	**Variance**	***SD***	**Correlation**		
Participants	0.016	0.128			
Items	0.001	0.037			
Color consistency	0.006	0.079	0.550		

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

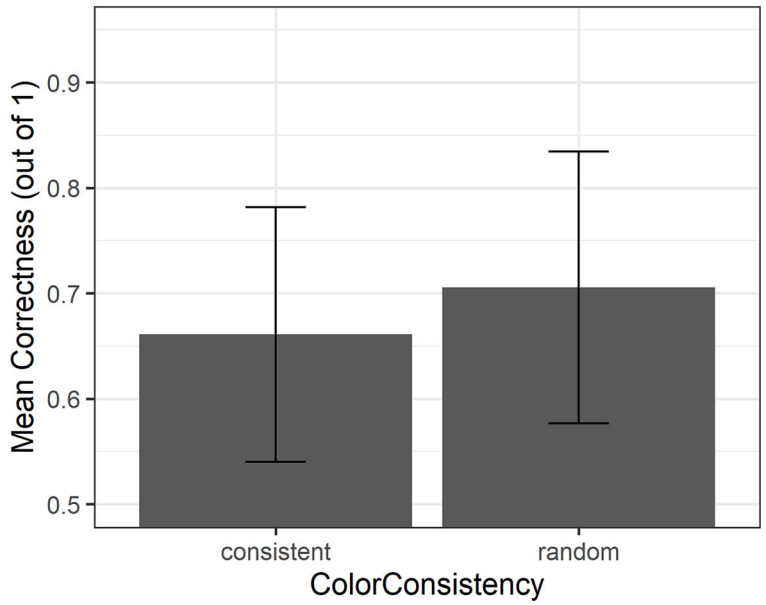

FIGURE 4
Mean correct responses by color consistency of speakers in Experiment 2. Bars represent the standard error of the mean.

regardless of whether speakers had consistently referred to objects of one color or not, and regardless of whether objects had been shown in black or white or in color. The performance of native listeners is in line with previous findings that suggest that listeners can adapt to speaker references during listening (e.g., Horton and Slaten, 2012) and that they can associate individual talkers with items that they label uniquely (e.g., McKinley et al., 2017). Additionally, the processing benefits for L1 listeners based on the presence of a pattern, even when it was not consciously recognized (e.g., Schacter et al., 2004), also seem to apply to conceptual patterns and source memory.

Non-native listeners, however, showed no measurable source memory benefits based on color consistency. The lack of such an effect in Experiment 1, with black and white images, led to the possibility that the reduced saliency of the aspect color may have contributed to it. Indeed, non-native speakers can have disadvantages during listening that we expected to make this task more challenging. For instance, L2 listeners are known to be less reliable in talker-identification in their L2 compared to identifications in their L1 (Bregman and Creel, 2014). Additionally, it's unclear whether categorical information, for instance semantic categories, shows the same benefits in L2 users compared to L1 users, as the possibility of interference may play a role (e.g., Waring, 1997). However, the use of well-known nouns, such as those used in the present study, may be beneficial in such category building (e.g., Fitzpatrick and Thwaites, 2020). In the presence of more challenges, and limited free processing resources (e.g., Sorace and Filiaci, 2006), as well as a lack of explicit instructions as to what information is relevant for the task (see e.g., Koster et al., 2018), we had expected that conceptual color may not be salient enough to be taken into consideration during processing, or rather, not

relevant enough to contribute to explicit source memory for non-native participants.

Nonetheless, we expected the presence of color in Experiment 2 to allow this category to be noticed, possibly even consciously, enough to possibly contribute to source memory. This was, however, not the case. Even with the presence of color, only three (out of 36) participants had consciously noticed the color consistent pattern of the speakers; two of these participants expressed unsureness, and one confidently named the pattern and indeed performed at 100% correct in the source memory task. As in Experiment 1, the exclusion of these participants from the analysis did not impact the overall results. Thus, conscious pattern recognition was still limited, and a lack of improved source memory based on the categorical condition suggests that unconscious categorical patterns based on color were also not constructed. Indeed, while categorical and perceptual shifts of color in L2 users have been examined (for an overview, see Athanasopoulos, 2011), access to color as a conceptual and perceptual aid during listening has not been explicitly examined in L2 research, to our knowledge, and prototypical color information may thus not be accessible for recall in global context building. Other conceptual information, such as more obvious semantic categories, may take priority in the presence of processing challenges such as those presented above. Indeed, looking at the offline responses of non-native participants in the debriefing questionnaire, participants were eager to look for patterns based on semantic categories (e.g., plants, inanimate objects, fruits, etc.), even though these patterns were not present (i.e., the categories only applied to a select few items). This is in line with studies that suggest that bilinguals may build more flexible category boundaries as experience in a second language increases (see e.g., Ameel et al., 2009).

However, there is much more research to be considered for future investigation, and this study marks only the beginning of a field of research that is largely unexplored, namely what source information native and non-native listeners rely on during communication. As the effect was found in L1 and not L2 listeners, it may be interesting to explore whether increasing the processing demands in native listeners would also reduce or eliminate the source memory effects found in L1 listeners in Experiment 1. This type of investigation could help to tease apart whether categorical difficulties presented by such an apparently difficult pattern (i.e. a perceptual category like color rather than a semantic category like plants/animals) as opposed to processing demands affect source memory. Exploring other types of speaker information, beyond a preference for objects of one color, may help to identify the parameters for which information about individual talkers is committed to memory. For instance, using other functional properties such as shape (see e.g., Vernon and Lloyd-Jones, 2003) in addition to conceptual, semantic properties, may help identify the limitations on the type of categorical information that may be used in the building of global contexts. Additionally, future studies may consider including more L1 and L2 speaker groups to verify that differences in encoding source memory based on patterns are indeed an L2 issue and are not due to cultural and or linguistic differences. While the current study accounted for cultural and linguistic differences based on the color pattern involved, the building of such global contexts and the information attended to during that process may be different based on individual speaker groups' categories.

Another direction for future investigation could be whether processing, rather than source memory, is impacted by patterns in non-native listeners. It may be the case that processing is indeed impacted, but this information is not available for explicit memory, something suggested by Horton and Slaten (2012) in their L1 findings. Indeed, studies considering eye-tracking during listening rather than source memory may give insight into whether non-native listeners are able to use speaker patterns for listening but are unable to remember it (e.g., Corps et al., 2023).

And, finally, extending the current study into a more communicative paradigm would be an important next step in identifying how source memory, explored in the current study, can be more directly applied to communication. The current study represents an important first step in identifying how L1 and L2 listeners encode information that may be necessary for successful communication, and future studies should consider how the information can be used or even updated in referential communication, for instance.

5 Conclusion

Our findings suggest that non-native listeners show reduced sensitivity to speaker-object associations based on prototypical colors—both when objects are presented only conceptually without color as well as perceptually with color. Non-native speakers, often lacking the same linguistic or even cultural information available to native speakers, would benefit greatly from an ability to commit talker information to memory, on all levels, and adapt this information into their common ground for use in conversation. But being able to build speaker-specific contextual memory representations not only has implications for ongoing conversations, but it might also form the basis for learning more general speaker patterns in a language. For example, female and male speakers can be associated with different stereotypical objects (e.g., dresses with women and ties with men), just as children and adults can be associated with different stereotypical objects. Exploring the framework of which information can be readily accessed during listening as well as which information is committed to memory can help to improve general outcomes in language learning and L2 communication. Thus, the findings presented here suggest some limitations on which source information L2 listeners can use in memory, and the study presents an even greater opportunity for a range of new investigations on the parameters of L2 listener memory and context building.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: OSF repository, https://osf.io/96pw4/?view_only=0b9be592234845f69138e4aab887815d.

Ethics statement

The studies involving humans were approved by the DFG (German Research Foundation) via a lab ethical approval. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SB: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing, Conceptualization, Visualization. AW: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing, Resources.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This study was funded by the Chair of Psycholinguistics and Applied Language Studies at the University of Tübingen.

Acknowledgments

We want to thank the many student assistants who helped prepare the experiment and collect the data. In particular, Stacie Boswell, Christiana Chaidaridou, Iryna Kavchuk, and Wenyi Chen. Additionally, we thank the reviewers, whose comments greatly improved the manuscript to its current state.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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