

RESEARCH ARTICLE

The role of the native language in auditory and visual context effect modalities

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Summary

Facilitation of memory for target stimuli due to similar context in the learning and testing phases is known as “context effect” (CE). The present study aimed to investigate the interaction between CE as elicited by the consistency of the language of presentation (Hebrew vs. English) with the native language (Hebrew vs. English) in both auditory and visual modalities. Overall, 120 individuals participated in the experiment. As predicted, CE was evident when the language of presentation remained consistent between study and test. Contrary to our prediction, Hebrew speakers remembered more English words, and vice versa. A possible explanation is that this difference is due to the cognitive effort invested when processing a less dominant language, thus resulting in better recognition. This study has several practical implications, including a recommendation that academic institutions test students in the language in which the material was presented in order to measure the students' knowledge more accurately.

KEYWORDS

context effect, learning, modality, native language

1 | INTRODUCTION

Context plays an important role in learning and memory (Hockley, 2008; McKenzie & Tiberghien, 2004). It is encoded automatically at the time of learning and has been shown to influence retrieval (McKenzie & Tiberghien, 2004; Smith, Handy, Angello, & Manzano, 2014; Vakil & Liberman, 2016). Targets, namely, the items that one is attempting to memorize, are encoded intentionally. They are better recognized or recalled at the test phase when the encoding context is present, which represents basic memory context effect (CE; Hockley, 2008; McKenzie & Tiberghien, 2004; Smith et al., 2014; Vakil & Liberman, 2016; Vakil, Raz, & Levy, 2010). During retrieval, the context stimuli are said to cue memory for its accompanying target (Vakil et al., 2010; Vakil & Liberman, 2016). CE in recognition memory offers an important assessment of associate learning in source memory (Levy, Rabinyan, & Vakil, 2008), and the importance of context in

memory retrieval has been acknowledged in several models of memory (Howard, Fotadar, Datey, & Hasselmo, 2005; Murnane & Phelps, 1993, 1994; Vakil et al., 2010).

Context may emerge in a variety of forms. It can take the form of local stimuli that accompany memory targets when they are processed (Levy et al., 2008; Vakil, Raz, & Levy, 2007), or it could be environmental, such as the room where one studied and where the memory was encoded (Smith & Vela, 2001). Another form of context is how the stimuli were presented, for example, auditory presentation or the color of the font used when presenting words (Hockley, 2008; Macken, 2002; Vakil, Openheim, Falck, Aberbuch, & Groswasser, 1997).

The modality of presentation (the modality in which the information is presented to the participants) also serves as a type of context (Besken & Mulligan, 2010; Loveman, van Hooff, & Gale, 2002; Vakil et al., 1997) and aids in the memory of items when the modality remains consistent between the learning and test phases. Numerous studies have found poorer memory for items when the modality of presentation (for instance, learning material visually and being tested

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on it orally) was altered—a modality effect (Loveman et al., 2002; Mulligan, Smith, & Spataro, 2016; Schacter, Dobbins, & Schnyer, 2004; Vakil et al., 1997). Additionally, search time was significantly slower when material was presented in a modality other than that in which it was originally presented, as compared with the same modality in an item recognition task (Baddeley, 2012). The most commonly researched type of modality is visual, with less research conducted in the auditory domain. Researchers have found that visual presentation acts as a primer for visual identification, but less research has been conducted in the auditory domain, and different studies have reported different effects on memory (Besken & Mulligan, 2010; Loveman et al., 2002; Mulligan et al., 2016). For instance, Mulligan et al. (2016) presented participants with a memory recognition task in both visual and auditory domains and demonstrated that material presented visually led to greater recognition than material presented orally. It should be noted that despite greater recognition in the visual modality, material presented and tested orally did produce a modality effect, though a lesser one. This coincides with reports from previous research (Leynes, Bink, Marsh, Allen, & May, 2003; Mulligan & Osborn, 2009; Mulligan, Spataro, & Picklesimer, 2014).

Vakil et al. (1997) conducted a study that examined the influence of modality on memory. Participants were presented with high-frequency words, half of which were presented visually and half presented auditorily. This was followed by a simple recognition test in which participants were again presented with previously exhibited “old” words (half in the same modality as in the learning stage and half in the opposite modality), along with new words in both modalities. Participants were asked to decide whether it is a new or an old word. In addition to the word recognition test, participants were asked about the modality in which the previously presented word was displayed. Vakil et al. discovered that the hit rate was higher when previously presented words were displayed in their original modality than when presented in a new modality. The study demonstrated the importance of modality consistency in memory processes. Future studies investigating modality should consider conducting their investigations in both the auditory and visual modalities in order to expand our understanding of these processes.

Keeping in mind earlier research on context and modality, we wish to expand upon previous investigations of CE and modality and add the language component as a measure of context. Marian and colleagues have demonstrated in a series of studies how, for bilingual individuals, consistency of language between encoding and retrieval (i.e., CE) improves memory. In a study with Russian–English bilinguals, their autobiographical memoirs of the period when they spoke in Russian or English were better when asked in Russian or English, respectively (Marian & Neisser, 2000). In another study, Marian and Fausey (2006) examined Spanish–English bilinguals’ academic material (e.g., History) in these two languages and found that their memory was more accurate and retrieved faster when the language at learning and testing was kept constant. Similarly, Mandarin–English bilinguals retrieved better general knowledge when asked about it in the same language in which it was acquired (Marian & Kaushanskaya, 2007). Numerous contextual factors influence the memorization process in foreign language learning. For instance, learning words together with their translation in one’s native language provides the learner with

more meaning and more associations (De Groot & Keijzer, 2000; Nation, 2003; Smith et al., 2014). Additionally, research has shown that foreign language learning was easier when the words were easier to pronounce or similar in form/meaning to words in one’s native language. Words in a foreign language that were considered phonologically legal in one’s native language and were composed of easily pronounceable sound sequences were easier to learn than words that differed phonologically (De Groot & Keijzer, 2000).

Context clearly plays a significant role in language learning. The present study expands upon current research by investigating how native language can elicit CE by serving as a contextual cue. It was hypothesized that material presented in the participant’s native language would be more easily remembered than when participants learn or are tested on the material in their second language. For instance, a native English speaker is likely to find it easier to learn and remember material when it is presented in English. Later, when tested on the same material, the participant’s native language (i.e., English) will cue memory of the previously studied material more strongly than would a foreign language.

Additionally, we hypothesized that regardless of native language, material presented in the same language during both the learning and test phases will be better recognized than material presented in different languages in each phase. Specifically, we predicted that consistency of context would produce a stronger effect (better recognition) than native language. Consistency of language (the main CE) was expected to facilitate memory activation for that material, whereas different languages in the different phases would lead to poorer performance and word recognition.

This study was designed to evaluate the interaction between CEs that are elicited by consistency of language of presentation (Hebrew vs. English), with native language (Hebrew vs. English) in visual and auditory modalities. This is the first study to test the interaction between modality, language of presentation, and native language, which gives ecological validity to the study. This research may be of vast importance, especially in countries in which academic studies are often based on material that is written in English, though students are tested on that material in a native language other than English.

2 | METHODS

2.1 | Participants

The participants in this study were 120 university students (82 females), ages 18–35 ($M = 25$, $SD = 4.37$). The students took part in the experiment to fulfill academic requirements. Based on self-reports, none had histories of neurological or psychiatric disorders. Participants were administered a self-report questionnaire that detailed their language preferences and language usage in both English and Hebrew (such as which language they speak at home, prefer to read in, be tested in, and which language they prefer to speak with an equally bilingual peer). Half of the participants were Hebrew-dominant speakers with Hebrew clearly defined as their native language. In order to be considered native Hebrew speakers, participants in this group were required to have studied and lived in Israel since first grade. In Israel, English is

taught from the fourth grade onwards, and Israelis must pass government matriculation exams that test their aptitude in English in order to graduate from high school. Israeli students are required to study English in university, unless they can demonstrate proficiency. Israelis are also frequently exposed to the English language through television shows and movies in English (with subtitles) and music.

The second group consisted of native English-dominant speakers, with English clearly defined as their native language. These participants were either new immigrants to Israel from English-speaking countries (such as Canada, Britain, South Africa, Australia, or the United States) or individuals who grew up in Israel in English-speaking households. Of the new immigrants in this group, many had studied Hebrew in their native countries in a Jewish day school or in afternoon Hebrew school programs and have had daily exposure to Hebrew since moving to Israel. All these participants were university students, studying in Hebrew. In order to be accepted to any university-level program, students who did not study previously in Israel must demonstrate Hebrew language proficiency by passing a government-level examination.

Half of the participants (half of the English speakers and half of the Hebrew speakers) were assigned to the auditory condition, and the other half were assigned to the visual condition, creating a total of four groups. These groups were as follows: native English speaker visual learning condition ($n = 30$); native English speaker auditory learning condition ($n = 30$); native Hebrew speaker visual learning condition ($n = 30$); and native Hebrew speaker auditory learning condition ($n = 30$). More detailed demographic data for all groups are shown in Table 1.

2.2 | Tools

2.2.1 | Questionnaire data

Demographics and language capabilities assessment questionnaire

Participants were asked to fill out a short, half-page questionnaire (created by the authors for the purposes of this study) on their age, gender, and other relevant information. The second half of the questionnaire addressed participants' language exposure (i.e., which language they speak with their friends). Comprehension of English or Hebrew as a second language was not assessed, as all university students have presumably passed their matriculation exams, including the English exam, and therefore are assumed to have basic knowledge of English. Likewise, as the native English speakers live in Israel and have studied at Israeli institutions, they are assumed to have passed standardized tests that assess Hebrew language proficiency.

2.3 | Procedures

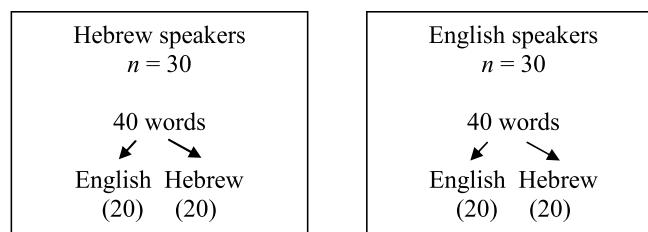
Because CE as a function of consistency of modality (visual vs. auditory) has already been demonstrated in a previous study (Vakil et al., 1997), the effects of language of presentation and native language were tested in two separate groups. The words were presented auditorily to one group and visually to the other (see Figure 1). The words used in the experiment were high-frequency Hebrew nouns or adjectives that were used in a previous experiment and their English

TABLE 1 Groups' demographics

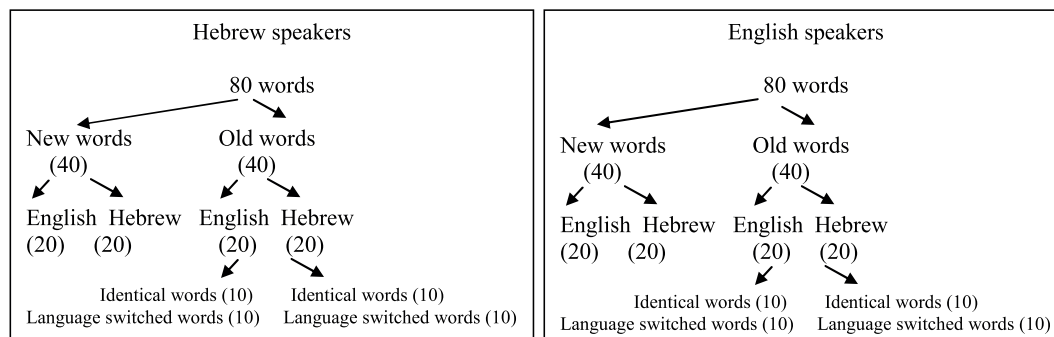
Group	Gender		Mean age (SD)	Place of birth		English-speaking country	Other	Move to Israel (years)	Language spoken at home			
	Male	Female		Israel					English	Hebrew	English and Hebrew	Other
English visual ($n = 30$)	6 (20%)	24 (80%)	24.3 (3.6)	11 (36.7%)		19 (63.3%)	0	15	23 (76.7%)	2 (6.7%)	5 (16.7%)	0
English auditory ($n = 30$)	11 (36.7%)	19 (63.3%)	24.8 (5.7)	13 (43.3%)		16 (53.3%)	1 (3.3%)	15.6	18 (60%)	0	11 (36.7%)	1 (3.3%)
Hebrew visual ($n = 30$)	8 (26.7%)	22 (73.3%)	25.5 (4)	27 (90%)		1 (3.3%)	2 (6.7%)	4.3	0	26 (86.7%)	0	2 (6.7%)
Hebrew auditory ($n = 30$)	13 (43.3%)	17 (56.7%)	25.6 (3.9)	27 (90%)		1 (3.3%)	2 (6.7%)	5	0	29 (96.7%)	0	1 (3.3%)

Note. English-speaking country includes the United States, Canada, and England.

I. Learning Phase – (for both the visual and auditory conditions)



II. Testing Phase – (for both the visual and auditory conditions)

**FIGURE 1** Experimental design

translations (Vakil et al., 1997). The words used were not similar to one another, to reduce the likelihood of participants mistaking one word for another. Before the study began, a pilot study of the visual modality was conducted with a procedure identical to that of the study described below, except that at the end of the experiment, participants were shown the list of words and asked to identify words that were unfamiliar to them. Ultimately, three words were replaced. The results of the pilot demonstrated a CE.

The experiment was conducted using SuperLab (SuperLab Pro 4.0.6, Stimulus Presentation Software, version 4.0.6) software and a notebook with a 10-in. screen. The same researcher (the first author) conducted all of the trials. During the learning phase in the visual condition, a new word was presented every 1.5 s at the center of the screen. During the subsequent testing phase, the word remained on the screen until the participant responded. All words appeared in font size 36. English words appeared in Times New Roman font, and Hebrew words appeared in David font. Under the auditory condition, all words were prerecorded by the same bilingual native Hebrew and English speaker. A new word was heard every 1.5 s as in the visual condition. While the participants were listening to the words, the instructions remained on the screen for the duration of the experiment, and participants were instructed to ignore them as best as they could. In the testing phase, participants heard a word and were instructed to respond to it before the next word was heard. The entire experiment took about 10 min.

After obtaining informed consent, participants were led to a computer to learn the words. Each participant was tested individually. The researcher gave the participants instructions for each segment of the experiment, as well as a visual demonstration on the computer screen (for both the auditory and the visual conditions; see Figure 1). Although the instructions appeared only in Hebrew, the researcher explained them in English or Hebrew, depending on the

participant's native language. Participants were told that they were going to see (in the visual condition) or hear (in the auditory condition) 40 words, 20 of which would be presented in Hebrew and 20 of which would be presented in English in random order. They were instructed to try to learn the words as best as they could for a later phase of the experiment. When participants felt that they were ready, they were instructed to press the space bar. Participants were not told that the language of the words would be changed later in the experiment.

Participants were given a 3-min break between the learning and testing phases. During this time, they filled out a short demographic questionnaire that assessed their language dominance in English and/or Hebrew. Participants remained in the room in which the experiment was conducted throughout the entire duration of the experiment.

At the testing phase, the experimenter explained the task to the participants, with a visual explanation (see Figure 1). They were told that they would view 80 words, 40 were in Hebrew and 40 in English (of the 80 words, 40 were new, foil words with structures that were identical to the 40 words from the learning phase). For each word, participants had to decide if the word had appeared in the previous phase of the experiment. They were then told that some of the words that had appeared in the previous phase in Hebrew could now appear in English, and vice versa. Of the 40 old words, 20 were in English and 20 were in Hebrew. Half of the English words (10) now appeared in Hebrew, and the remaining 10 remained in English. Of the Hebrew words, 10 remained in Hebrew and 10 now appeared in English. It was emphasized both verbally and on the instruction slide that if the word appeared in the previous phase (even in a different language), participants should press the "yes" button on the keyboard and "no" if the word did not appear in either language. The researcher made sure that participants understood this instruction before the

experiment continued. Once participants were ready, they were told to press the space bar to begin.

After completing the experiment, all participants received an in-depth description of the purpose and the implications of the study. Participants were encouraged to ask questions, and those who were interested were shown how many words they identified correctly. The university's institutional review board approved the project.

3 | RESULTS

Performance of native Hebrew and English speakers on a recognition memory task was compared in this study. Words were presented in either English or Hebrew, auditorily or visually. The language of presentation and the modality of presentation during the learning phase and the testing phase were either constant or not constant. Mean words recalled (and SEs) under the various conditions are presented in Figure 2. Hit rates and false alarm rates were analyzed separately.

In addition to the number of words recalled, we analyzed reaction time (RT) as an additional dependent measure. Previous studies have used RT with bilinguals to assess how quickly they can respond to naming a picture, for instance, when the language in which they respond changes (e.g., Misra, Guo, Bobb, & Kroll, 2012).

3.1 | Hit rates

In order to simultaneously examine the interaction between all variables, a four-way mixed design analysis of variance (ANOVA) was conducted to analyze the effect of between-subjects factors, native language (English vs. Hebrew) and modality of presentation (visual vs. auditory), and within-subjects factors, language of presentation (English vs. Hebrew) and context (constant vs. not constant). Analysis of the results revealed that context main effect reached significance, $F(1, 116) = 223.56, p > 0.001, \eta_p^2 = 0.658$, as predicted. Namely, participants recognized more words when the language of presentation remained constant (the language that participants see or hear during encoding) between study and test ($M = 70.43, SE = 1.42$), as opposed to not constant ($M = 50.52, SE = 1.15$).

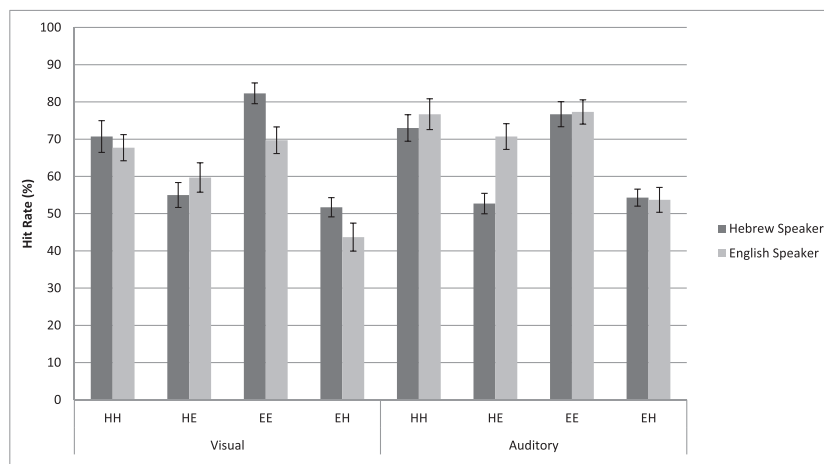
Native language main effect did not reach significance ($p > 0.05$) when comparing Hebrew speakers ($M = 60.45, SE = 1.58$) and English speakers ($M = 60.49, SE = 1.58$). Language of presentation, Hebrew ($M = 60.58, SE = 1.53$) and English ($M = 60.37, SE = 1.22$), did not reach significance ($p > 0.05$). The modality effect, visual ($M = 60.25, SE = 1.58$) and auditory ($M = 60.69, SE = 1.58$), showed a trend towards significance, $F(1, 116) = 3.75, p = 0.055, \eta_p^2 = 0.031$.

These effects should be interpreted cautiously because some of the interactions reached significance. Context by native language interaction reached significance, $F(1, 116) = 6.16, p > 0.05, \eta_p^2 = 0.050$. As can be seen in Figure 3, CE (i.e., constant > not constant) was more pronounced in the Hebrew-speaking group than the English-speaking group. Another significant interaction was observed between language of presentation and context, $F(1, 116) = 18.61, p < 0.001, \eta_p^2 = 0.138$. As can be seen in Figure 4, CE was more pronounced for words presented in English than for words presented in Hebrew. Language of presentation by native language also produced a significant interaction, $F(1, 116) = 11.38, p > 0.001, \eta_p^2 = 0.089$. Surprisingly, Hebrew speakers recognized more words in English, whereas English speakers recognized more words in Hebrew (see Figure 5). A significant interaction was also observed between native language and modality, $F(1, 116) = 5.15, p > 0.05, \eta_p^2 = 0.043$. As can be seen in Figure 6, Hebrew speakers performed similarly when examined visually or auditorily, whereas English speakers performed better in the auditory condition than in the visual condition.

3.2 | False alarms

A three-way mixed design ANOVA was conducted to analyze the effects of language of presentation, native language, and modality. A significant main effect was found for language of presentation, $F(1, 116) = 5.33, p < 0.05, \eta_p^2 = 0.044$. Participants incorrectly identified more new Hebrew words ($M = 5.04, SE = 0.288$) as old words than they did in English ($M = 4.43, SE = 0.269$). Native language main effect did not reach significance ($p > 0.05$) when comparing Hebrew speakers ($M = 40.53, SE = 3.46$) and English speakers ($M = 40.93, SE = 3.46$). Additionally, modality did not reach significance ($p > 0.05$), visual ($M = 50.09, SE = 3.46$) and auditory ($M = 40.38, SE = 3.46$).

FIGURE 2 Hit rate percentage (SE) of words in the four conditions, as a function of language presentation in the learning and testing phases: HH: Hebrew at learning Hebrew at test; HE: Hebrew at learning English at test; EE: English at learning English at test; EH: English at learning Hebrew at test. Context effect emerges consistently for Hebrew and English language of presentation under either visual or auditory modality



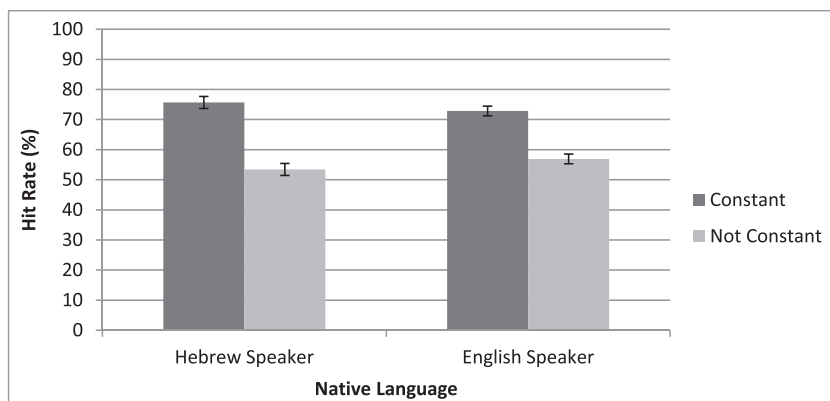


FIGURE 3 Hit rate percentage (SE) of words, as a function of native language and context (constant or not constant). More pronounced context effect for Hebrew than for English speakers

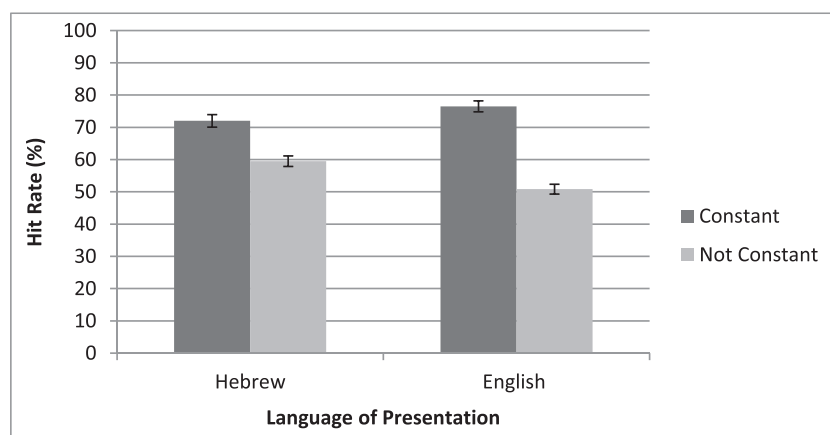


FIGURE 4 Hit rate percentage (SE) of words, as a function of context (constant or not constant) and the language in which words were presented. More pronounced context effect under English than Hebrew presentation

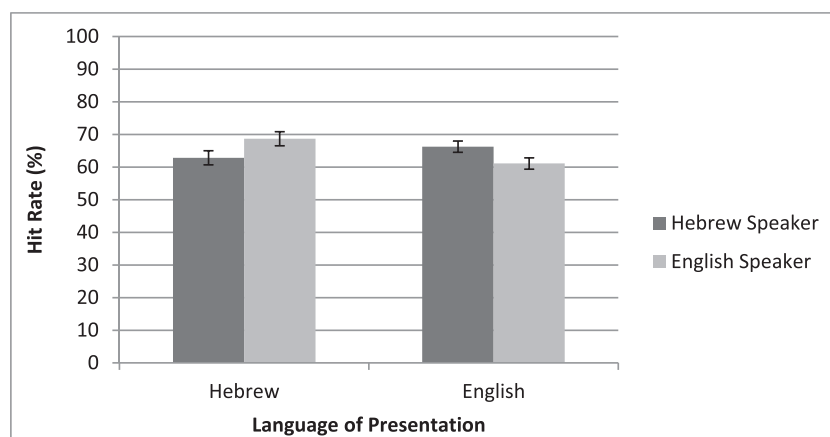


FIGURE 5 Hit rate percentage (SE) of words correctly recognized, as a function of native language and language of presentation. Hebrew speakers remember English better than Hebrew words and vice versa

SE = 3.46). These main effects should be interpreted cautiously because of the significant interaction found between native language and modality, $F(1, 116) = 4.322$, $p < 0.05$, $\eta_p^2 = 0.036$. English speakers produced the same degree of false alarms whether words were presented auditorily or visually, whereas Hebrew speakers tended to produce more false alarms when words were presented visually (see Figure 7). No other interactions reached significance.

3.3 | Reaction time

A three-way mixed design ANOVA was conducted to analyze the effects of native language (English vs. Hebrew), language of presentation (English vs. Hebrew), and context (constant vs. not constant), which were analyzed separately for the visual and auditory modalities. The former is a between-subjects factor, and the latter two are within-subjects factors.

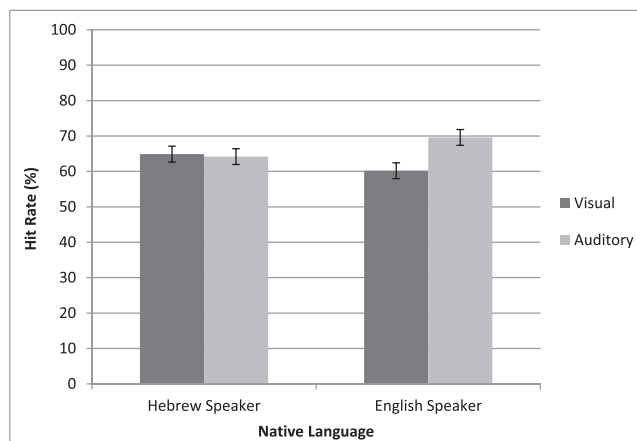


FIGURE 6 Hit rate percentage (SE) of words, as a function of native language and modality. Hebrew speakers performed similarly when examined visually or auditorily, whereas English speakers performed better in the auditory condition than in the visual condition

For the visual modality, main effect of context reached significance, $F(1, 58) = 46.04$, $p < 0.001$, $\eta_p^2 = 0.44$. As can be seen in Table 2, overall RT was faster when language of presentation remained constant than not constant between study and test. The triple interaction reached significance as well, $F(1, 58) = 4.86$, $p < 0.05$, $\eta_p^2 = 0.08$. As can be seen in Table 2, when the native language is Hebrew, the increase in RT when presentation changes from Hebrew to English is much more pronounced than a change from English to Hebrew. However, when the native language is English, an equal increase in RT is observed, whether from Hebrew to English or vice versa. The other main effects and interactions did not reach significance ($p > 0.05$).

For the auditory, just like the visual modality, the main effect of context reached significance, $F(1, 58) = 7.62$, $p < 0.01$, $\eta_p^2 = 0.12$. As can be seen in Table 3, overall RT was faster when language of presentation remained constant than not constant between study and test. The language of presentation and context interaction reached significance as well, $F(1, 58) = 4.56$, $p < 0.05$, $\eta_p^2 = 0.07$. As can be seen in Table 3, the increase in RT when changing language of presentation from English to Hebrew is significantly higher than when changing from Hebrew to English. The other main effects and interactions did not reach significance ($p > 0.05$).

TABLE 2 Visual modality: Reaction time (RT) as a function of native language, language of presentation, and consistency of presentation between learning and testing phases

Native language	Language of presentation		Mean RT (ms)	SE
	Learning phase	Testing phase		
Hebrew	Hebrew	Hebrew	1,075.88	80.12
	Hebrew	English	1,588.90	103.64
	English	English	1,125.87	92.45
	English	Hebrew	1,295.07	93.36
English	Hebrew	Hebrew	1,266.68	80.12
	Hebrew	English	1,541.67	103.64
	English	English	1,321.42	92.44
	English	Hebrew	1,613.90	93.36

4 | DISCUSSION

The study aimed to investigate the interaction between CE as elicited by the consistency of language of presentation (Hebrew vs. English), with native language (Hebrew vs. English), in both auditory and visual modalities. Although previous studies have already demonstrated the CE of modality of presentation (Besken & Mulligan, 2010; Loveman et al., 2002; Vakil et al., 1997), this is one of the first studies to examine the relationships between these variables simultaneously (i.e., consistency of language of presentation, native language, and modality).

Overall and as predicted, CE was evident when language of presentation remained constant between study and test. This adds to the ever-growing body of research that shows how important CE is in learning and memory (Hockley, 2008; McKenzie & Tiberghien, 2004; Smith et al., 2014; Vakil et al., 1997, 2007, 2010). CE was also expressed with the RT results, namely, that response was faster when the language of presentation remained constant between study and test for both modalities (see Tables 2 and 3). This research demonstrates CE and language specificity in memory, regarding the manner in which information is stored (Hernandez, Dapretto, Mazziotta, & Bookheimer, 2001). Material learned in one language appears to have a different memory representation than that of its translation, showing language specificity (Kirsner, Brown, Abrol, Chadha, & Sharma, 1980; Kroll, 1993; Scarborough, Gerard, & Cortese, 1984).

FIGURE 7 False alarm rate percentage (SE) of words, as a function of native language and modality. English speakers produced the same degree of false alarms whether words were presented auditorily or visually, whereas Hebrew speakers produced more false alarms when words were presented visually than auditorily

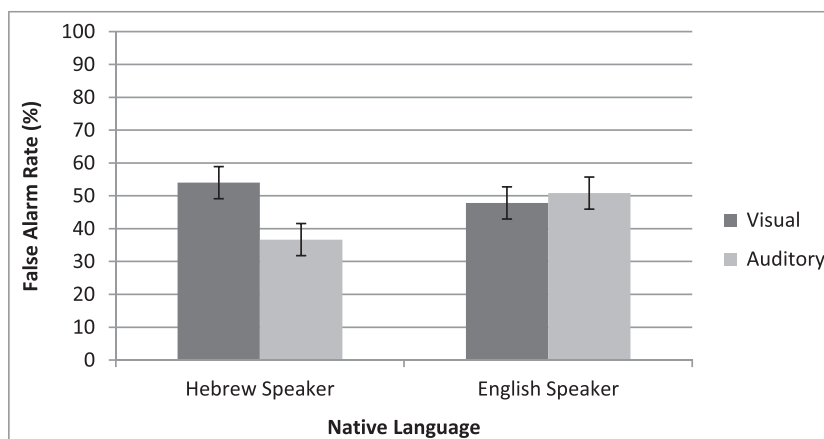


TABLE 3 Auditory modality: Reaction time (RT) as a function of language of presentation and consistency of presentation between learning and testing phases

Language of presentation		Mean RT (ms)	SE
Learning phase	Testing phase		
Hebrew	Hebrew	750.21	67.83
Hebrew	English	764.97	62.62
English	English	626.69	60.05
English	Hebrew	839.88	78.36

Interestingly, as can be seen in Figure 3, CE was more pronounced for Hebrew speakers than for English speakers. This is also consistent with the RT results. The increase in RT as a result of changing language of presentation was greater for the Hebrew than the English speakers, at least in the visual modality (see Table 2). This disparity in performance may be due to the different realities facing English and Hebrew speakers living in Israel. The official language spoken in Israel is Hebrew, and therefore, Hebrew speakers converse almost entirely in Hebrew. English speakers in Israel will frequently alternate between the two languages. English speakers must be prepared to use either language depending on the situation and would therefore be less influenced by the change in language than Hebrew speakers (Bialystock, 2009; Kaushanskaya & Marian, 2007).

Unexpectedly, CE was more pronounced for words presented in English than for words presented in Hebrew, regardless of the modality of presentation (see Figure 4). These results suggest that words presented in English were more rigidly bound to their meanings than the Hebrew words and, therefore, the cost was greater (lower hit rate) when the words were translated to Hebrew. Interestingly, this was also expressed, but only under auditory presentation, with the RT measure (i.e., more pronounced increase in RT when language of presentation changed from English to Hebrew than vice versa; see Table 3).

One finding in the study that did not coincide with our hypothesis was the interaction between native language and language of presentation. Hebrew speakers remembered more English words, and English speakers remembered more Hebrew words (see Figure 5). A possible explanation is that this difference is due to the level of processing and cognitive effort required when processing a less dominant language. A study by Costa and Santesteban (2004) demonstrated increased difficulty when switching from the weaker to the more dominant language. The inhibitory control model by Green (1998) attempts to explain this inherent difficulty by stating that use of a nondominant and less proficient language requires more inhibition of the dominant language than vice versa. This greater level of inhibition requires more cognitive resources and makes it more difficult to switch back to the dominant language (Costa & Santesteban, 2004; Krizman, Skoe, Marian, & Kraus, 2014; Kroll, Bobb, Misra, & Guo, 2008). Evidence from brain imaging and electrophysiological studies also supports the idea that language switching requires inhibition (Green, 1998; Hernandez et al., 2001). A greater level of suppression could explain why Hebrew speakers remembered more English words, because they had to suppress Hebrew words that required more control than suppressing English. The same is hypothesized for the English speakers.

An alternative explanation is supported by the word frequency effect (Malmberg, Steyvers, Stephens, & Shiffrin, 2002). This theory states that when single words are learned, lower frequency words are better recognized than higher frequency ones (Glazer & Adams, 1985). This is based on the assumption that these words are more distinct in nature, though researchers struggled to define what it means for a word to be "distinct" (Malmberg et al., 2002). In the present study, Hebrew speakers may have recognized more English words than Hebrew words because English is not their native language and, therefore, the words appear less frequently in their lives. The same explanation can be applied to English speakers in order to explain why they recognized more Hebrew words.

Further analysis of these results showed a difference in performance between Hebrew and English speakers in the auditory and visual modalities (see Figure 6). Interestingly, although Hebrew speakers performed consistently in both modalities, English speakers performed better in the auditory condition. The Hebrew speakers' performance is similar to that reported by Besken and Mulligan (2010) and Brand and Jolles (1985), whose results demonstrated similar performance in visual and auditory modalities.

The English speakers' superior recognition under the auditory condition raises some interesting questions. However, it is worth noting that other studies that compared modality were conducted exclusively in English (with the exception of Vakil et al., 1997), whereas the present study used both English and Hebrew words. The differences between the two languages may have implications on modality. One of the inherent difficulties presented by the visual condition is the different alphabets and characters in the two languages. The Hebrew alphabet consists of 22 letters, whereas the English alphabet consists of 26. Hebrew and English lettering are completely different, as the former is a Semitic language and the latter is a Latin language. Another major difference is that Hebrew is read right to left, whereas English is read left to right (Gollan, Forster, & Frost, 1997). These differences add a dimension of difficulty to the visual condition that is irrelevant to the auditory condition and may explain why the English speakers were able to recognize more words in the auditory condition than in the visual condition. This coincides with the similar false alarm rates in the Hebrew-speaking group for both modalities, as opposed to the English-speaking group that yielded more false alarms when words were presented auditorily (see Figure 7).

This study highlights the importance of consistency in testing conditions in educational institutions. The results of this study indicate that tests should be given in the same language in which students were taught. Learning and testing in different languages appear to

result in poorer performance (Scarborough et al., 1984; Smith et al., 2014). These results are consistent with the series of studies conducted by Marian and colleagues (Marian & Fausey, 2006; Marian & Kaushanskaya, 2007; Marian & Neisser, 2000), demonstrating the role of language as context yielding CE with autobiographical memoirs, academic material, and general knowledge. Although in the present study the effect of language was only examined for recognition and not for recall, this does not underscore its importance. Further studies should examine whether or not this effect appears when participants learned information in one language and are instructed to recall it in another language. Moreover, future studies should investigate the interaction between the three factors tested here, language of presentation, native language, and modality, not on a word list but on more ecologically valid material such as that tested by Marian and colleagues (i.e., autobiographical memoirs, academic material, and general knowledge).

As described in Section 2, in order to assess participants' language capabilities, we used a questionnaire that we developed for this purpose. We consider this to be a weakness of this study, because we should have used a standard language proficiency test such as the Language History Questionnaire (Li, Zhang, Tsai, & Puls, 2014). It is important to note that we do not presume that English-dominant or Hebrew-dominant speakers are bilingual, rather that they have exposure and a level of proficiency in the second language. Therefore, it would be interesting to replicate this study with bilingual individuals. With bilingual individuals, the comparisons could be conducted as a within-subjects paradigm rather than between-subjects paradigm as was done here, by comparing individuals with English versus Hebrew as their native language. It is predicted that because within-subjects comparisons have greater statistical power than between-subjects comparisons, the differences observed in the present study would be more pronounced (i.e., CE of language of presentation; see Figures 3 and 4). Conversely, the finding that Hebrew speakers remember English better than Hebrew words and vice versa (see Figure 5) might fade, because for bilinguals, the transition from one language to another does not require the cognitive effort (which enhanced recall) required from participants in the present study with one dominant language.

Another aspect of the procedure that should have been done differently is that the instructions were presented visually on the computer screen while participants were performing the encoding portion of the task. This could have created a situation of divided attention, which impedes memory performance. That was not the case for participants who only saw the words visually, but did not receive any auditory input. However, in retrospect, this procedure did not affect the results (Hebrew speakers performed similarly in both conditions, whereas the English speakers performed better in the auditory condition). Future studies should avoid such a condition that might have interfered with the task.

In conclusion, this study adds to the growing body of research on the importance of context in learning and memory. When the learning context (such as the language of presentation) changes between the learning and testing phases, this has profound effects on memory of the material learned. Constant context results in increased and more effective recognition of the material that was learned, regardless of

native language. As suggested above, this has profound implications for academic institutions that teach information in one language and test in another. Another interesting and unexpected finding is that recognition of words improved when they were not presented in the participant's native language. This may have occurred because of deeper encoding and processing of words in the participant's second language. It would be interesting to see whether this finding persists for more complex verbal material such as sentences or paragraphs, as opposed to single words.

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