Appendix S1

Summary of Empirical Studies with LLAMA D and Language Outcome Measures

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Study | Participants | LLAMA D instructions | Target features | Outcome measures | Results |
| Artieda & Muñoz (2016) | Spanish-Catalan bilingual English language school students in Spain (beginner, *n* = 52; intermediate, *n* = 88) | Memorization | General English (incl. reading, listening, writing, & speaking) | End-of-year school exam | Sig. relationship for beginners (*r* = .40), but not for intermediates |
| Bylund & Ramírez-Galan (2016) | L1 Spanish (late) L2 Swedish adults in Sweden (*N* = 39) | No info | Spanish number agreement, gender agreement, verbal clitics, & aspectual  contrasts | Aural GJT | No relationship |
| Castro (2016) | L1 Spanish English major univ. students in Costa Rica (*N* = 17) | No info | Incidental English non-word learning from written input | Receptive and productive tests of orthographic, grammatical, & semantic aspects of non-words | Sig. relationship with grammatical aspect (receptive, *r* = .64; productive, *r* = .50), but not with orthographic or semantic aspects |
| Curcic, Andringa, & Kuiken (2019) | L1 Dutch students or highly educated adults in the Netherlands (*N* = 100) | No info | Determiner-noun agreement in a miniature language | Visual-world eye-tracking paradigm | No relationship (but positive relationship with pattern awareness) |
| Drozdova, van Hout, & Scharenborg (2017) | L1 Dutch L2 English univ. students in the Netherlands (*N* = 39) | No info | Native English speakers’ voice recognition | Multiple-choice speaker decision | No relationship |
| Drozdova, van Hout, & Scharenborg (n.d.) | L1 Dutch L2 English people (*n* = 114); L1 English people (*n* = 99) | No info | /l/ and /ɹ/ | Phonetic categorization task | Sig. relationship with *less* lexical retuning for NNSs No relationship for NSs |
| Forsberg Lundell & Sandgren (2013) | L1 Swedish (advanced late) L2 French adults in France (*N* = 13) | No info | French verb-noun collocations; subject-verb agreement, noun-phrase agreement, anaphors, verb constructions, & time, mode, aspect | Written fill-in-the-blank test; written GJT | Sig. relationship with collocations (*r* = .58), but not with GJT |
| Granena (2013) | L1 Chinese (advanced) L2 Spanish adults in Spain (early learners, *n* = 50; late learners, *n* = 50) | Just listen | Spanish agreement and nonagreement structures | Written GJT with error correction & aural word-monitoring task | Sig. relationship with agreement (*r* = .41) (but not nonagreement) structures for early (but not late) learners on GJT (but not word-monitoring) |
| Granena (2019) | L1 English (intermediate) L2 Spanish univ. students in the U.S. (*N* = 135) | Just listen | Syntactic complexity, lexical complexity, accuracy, fluency in Spanish | Picture description task | Sig. relationships with greater lexical complexity (*r* = .17) and less accuracy (*r* = −.19) |
| Granena & Long (2013) | L1 Chinese (advanced) L2 Spanish adults in Spain (AOA 3-6 group, *n* = 20; AOA 7-15 group, *n* = 27; AOA 16-29 group, *n* = 18) | Just listen | Spanish phonology; lexis and collocations; morphology and syntax | Accentedness judgment by NSs (passage read-aloud); written and aural, receptive and productive vocab and collocation tests; aural GJT, narrative retelling, word-order preference tasks, & gender decision | Marginally sig. relationship with lexis and collocations (*r* = .46) for AOA 16-29 group |
| Lee (2018) | L1 Korean English major univ. students in Korea (*N* = 83) | Memorization | Syntactic complexity, lexical diversity, & accuracy in English | Writing tasks (composition) | Sig. relationship with accuracy |
| Li & Qian (2021) | L1 Chinese English major univ. students in China (*N* = 166) | No info | 17 grammatical features in English (e.g., simple past, embedded questions) | Written GJT with error correction, metalinguistic knowledge test, & elicited imitation test | No relationship |
| Montero, Donate, Dixon, & Long (2018) | L1 English (advanced) L2 Spanish univ. students in the U.S. (*N* = 41) | Just listen | Spanish noun gender marking | Timed and untimed gender decision of non-words | No relationship |
| Moorman (2017) | L1 English L2 Spanish univ. students in the U.S. (2nd semester, *n* = 13; 6th semester, *n* = 31) | Memorization | Spanish mid vowels /e/ and /o/ | Word read-aloud (longitudinal) | Sig. relationship with /o/ positively (F1: *r* = .33) and negatively (duration: *r* = −.52) for 6th semester students |
| Mueller (2017) | L1 Korean L2 English adults in the U.S. (AOA 3-9 group; AOA 10-16 group; AOA ≥ 17 group; NS group, each *n* = 20) | No info | Sound-symbolic intuitions | Aural non-word-visual matching (exp.1); aural visual-non-word matching (exp.2); written productive test of learned non-words (exp.3) | Sig. relationships for AOA 10-16 (*r* = .81 [exp.1]; *r* = .63 [exp.2]; *r* = .59 [exp.3]) and AOA ≥ 17 (*r* = .81 [exp.1]; *r* = .84 [exp.2]; *r* = .63 [exp.3]) groups (but not for AOA 3-9 and NS groups) |
| Rodríguez Silva (2017) | L1 Spanish English language school students in Mexico (intermediate; upper-intermediate; advanced, each *n* = 30) | Memorization | Regular past tense, conditional, 3rd person -*s*, comparative, verb complements, article, modal verbs, many/much, plural, yes/no questions, since/for, dative alternation, & relative clauses in English | Elicited imitation test, oral narrative test, & metalinguistic knowledge test | No relationship |
| Saito (2017) | L1 Japanese (late) L2 English 2nd year univ. students in Japan (*N* = 50) | Sound check | Pronunciation (segmentals, word stress, & intonation), fluency (breakdown & speed), vocabulary (appropriateness & richness), & grammar (accuracy & complexity) in English | Oral picture narrative task | No relationship |
| Saito (2019) | L1 Japanese (late) L2 English 2nd year univ. students in Japan (*N* = 50) | Sound check | English /ɹ/ | Timed picture description task, sentence read-aloud, & word read-aloud | No relationship |
| Saito, Suzukida, & Sun (2019) | L1 Japanese (late) L2 English 1st year univ. students in Japan (*N* = 40) | Sound check | Comprehensibility, segmental, syllabic, prosodic, & temporal (breakdown, speed, & repair fluency) aspects in English | Timed picture description task (longitudinal) | No relationship (Semester 1) Sig. relationship with comprehensibility (*r* = .44), segmental (*r* = .33), & syllabic (*r* = .37) (Semester 2) |
| Suzuki (2021) | L1 Japanese L2 English univ. students in Japan (*N* = 59) | Sound check | Utterance fluency (speed fluency & breakdown fluency) in English | Oral narrative story task | No relationship (but when LLAMA D old and new items were analyzed separately, sig. relationship between the coefficient of variance of old items and breakdown fluency, *r* = .35) |
| Wucherer & Reiterer (2018) | L1 German English major univ. students in Austria (*N* = 64) | No info | English phonology; Hindi phonology; English grammar | Accentedness judgment by NSs (read-aloud; imitation); (written) TOEFL | No relationship |
| Yalçın & Spada (2016) | L1Turkish L2 English 8th graders in Turkey (*N* = 62) | No info | Passive, past progressive in English | Written GJT, picture-cued oral production task (pre-/post-tests) | Sig. relationship with past progressive on pre-test GJT (*r* = .27) |
| Yi (2018) | L1 Chinese L2 English univ. students in the U.S. (*n* = 32); L1 English univ. students (*n* = 30) | Memorization | English adjective-noun collocations | Phrasal acceptability judgment task (reaction time & accuracy) | Sig. relationship with accuracy (*r* = .25) for L2 learners |

Appendix S2

The Study Eligibility Criteria

Participants needed to meet all the following eligibility criteria: (1) between the ages of 18 to 40, (2) native speaker of English, (3) no knowledge of Russian, Chinese, or Japanese, (4) no experience using another language on a regular basis (e.g., speaking Spanish at home), (5) no experience staying in a non-English speaking country for more than a month, (6) no experience taking college foreign language courses for more than two years, and (7) normal or corrected-to-normal vision and hearing with no learning disabilities or optical/hearing problems (e.g., color blind). The age limits were included to minimize confounds related to cognitive development and aging. Because some of our tests assumed participants’ L1 to be English and one test used Russian, Chinese, and Japanese as unknown language stimuli, language requirements were specified accordingly. Participants’ exposure to other languages was kept minimal, as second language learning experience might affect aptitude test results (see Rogers et al., 2017).

Appendix S3

LLAMA D Test Instruction Scripts

Memorization Condition:

The first task is about sound. You will first hear 10 foreign words. Please memorize them to the best of your ability. In the test that follows these words, you will hear a series of foreign words. Some of these may be repeated from the list of 10 words you heard earlier, and others are new words. Your task is to decide whether you have heard each word earlier or not. You will now hear a recording of 10 foreign words. The recording will be played only once, so listen carefully and do your best to memorize them. Ready?

[The recording is played]

You will hear a series of foreign words. Please click the smiley face if you think you have heard the word in the previous set. Click the sad face if you think you did not hear the word previously. Click the arrow to move to the next question.

[The test is taken]

This is the end of this task.

Just-Listen Condition:

The first task is about sound. You will hear a set of words in a foreign language that you are not familiar with. Your task is simply to listen carefully. Ready?

[The recording is played]

You will hear a series of foreign words. Please click the smiley face if you think you have heard the word in the previous set. Click the sad face if you think you did not hear the word previously. Please just follow your gut feeling when you make a decision. Click the arrow to move to the next question.

[The test is taken]

This is the end of this task.

Sound-Check Condition:

The first task is about sound. Before we start, we will do a sound check. Please listen to this next recording and make sure that you can hear sound without any difficulty.

[The recording is played]

Now, I said this was a sound check, but I actually want you to do something with what you have just heard. You will hear a series of foreign words. Please click the smiley face if you think you have heard the word in the previous set. Click the sad face if you think you did not hear the word previously. Please just follow your gut feeling when you make a decision. Click the arrow to move to the next question.

[The test is taken]

My apologies for tricking you by telling you the first recording was a sound check. Could you please tell me about your mental state during the sound check stage? Did you just check the volume during the sound check stage? Or did you also pay attention to the foreign words? Did you also try to memorize the words?

Appendix S4

Correlation Matrix for the Six Measures (N = 109)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Measure | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. SRT | - |  |  |  |  |  |
| 2. ALTM | -.09 | - |  |  |  |  |
| 3. Paired associates | .01 | .19† | - |  |  |  |
| 4. Digit span | -.08 | .04 | -.04 | - |  |  |
| 5. Stroop | .01 | .21† | .11 | .02 | - |  |
| 6. Sound discrimination | .02 | .12 | .11 | -.09 | .04 | - |

*Note.* SRT = probabilistic serial reaction time task; ALTM = available long-term memory task. Daggers (†) indicate marginal significance (i.e., not significant with the Bonferroni correction, *p* < .0033, but significant without the correction, *p* < .05).

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