Pre-service teacher beliefs: Does perceptual learning-style matching increase initial L2 vocabulary learning?

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Summary: The meshing hypothesis is an assumption held by a majority of educators that students will learn better if material is presented to them in a single mode that matches their preferred learning style. In this randomized between-groups, mixed-methods study of initial L2 vocabulary learning, 100 pre-service teachers were trained and tested with either auditory or visual input. Results showed that no matter the preferred learning style, participants who took the visual test performed significantly better than participants who took the audio test. A majority of participants believed that style matching affected their vocabulary learning.

Keywords: pre-service teacher, beliefs, perceptual learning style, matching, meshing hypothesis, L2 vocabulary learning

Introduction

Many educators believe that learners innately attend to information in a way that best optimizes their learning based upon individual learning styles. Up to 93 percent of educators in the UK and 96 percent in the Netherlands assumed that matching learning styles improves learning (Dekker, et al., 2012), and in one U.S. survey of 596 educators, 76 percent believed that matching learning styles to instruction increases learning (MacDonald et al., 2017). Learning style preferences are ostensibly related to relatively stable and fixed biological or personality traits (Coffield et al., 2004). From a praxis standpoint, teachers hope to increase classroom learning by employing the *meshing hypothesis*, an assumption that students will learn better and with fewer frustrations if material is presented to them in a single mode that matches their preferred learning style (Pashler et al., 2008).

A review of over 800 learning styles studies (Coffield et al., 2004) highlighted the challenges of assessing the validity and reliability of research claims for the meshing hypothesis. The authors reviewed 13 studies related to different learning styles models and instruments. The review revealed that "after more than 30 years of research, no consensus has been reached about the most effective instrument for measuring learning styles and no agreement [has been] reached about the most appropriate pedagogical interventions" and that no significant style-matching gains can be shown (p. 145).

One limiting factor is that very few studies have used a design to test for crossover interactions between groups based on learning-style preferences, learning aptitude, or both; an extensive literature review of style-based interventions concluded that only about 20 studies were experimentally sound based upon this criterion, and of those, 17 had "compellingly negative results," and the remaining three had unconvincing outcomes (Pashler et al., 2008; Rohrer & Pashler, 2012).

Challenging inverventions based upon the meshing hypothsis, the author of an L2 vocabulary study of university students learning Spanish concluded the following: "Ultimately, then, the current study cannot be considered to uphold the superiority of style matching over style mismatching in vocabulary learning on a large scale" (Tight, 2010, p. 818). In line with Macedonia (2015), while it is true that students express learning-style *preferences*, it has not been empirically shown that their conscious awareness of those biases influences unconscious neural processing of input. In other words, the L2 vocabulary learner does not selectively process and store information in one region of the brain in a way that is better than in another region, giving the learner a "dominant" style. Style preference and ability are not necessarily correlated.

Responding to research, Pearson Education, which has created learning-styles curricula for K-12 students, called for more evidence before researchers dismiss the influence of learning styles: "It would be a mistake to conclude that the style-matching hypothesis is definitively false. It is impossible to definitively prove an effect doesn't exist and future research may validate the usefulness of learning styles in education" (2016). Adding to the debate, other researchers report with near certainty that the meshing hypothesis is a neuromyth (Dekker et al., 2012; Macedonia, 2015; MacDonald et al., 2017).

Given the reported negative relationship between learning-style matching and outcomes (Coffield, et al, 2004; Pashler et al., 2008; Tight, 2010; Macedonia, 2015), understanding preservice teachers' beliefs about employing the meshing hypothesis may be useful in several ways. First, understanding preservice teachers' actual beliefs about learning-style matching may reveal a potential mismatch between those beliefs and actual outcomes. Second, it is important to assess potential outcomes associated with a belief in the inherent efficacy of learning-style matching. Educators who diversify classroom input with style matching may see increased student learning and more "evidence" of meshing. This outcome, however, likely results from multimodal input—not meshing—since L2 vocabulary learning is enhanced when training includes more than auditory or textual input alone (Tight, 2010; Macadonia, 2015). That is, ". . . this particular neuromyth presents a challenge to the education field because it seems to be supporting effective instructional practice, but for the wrong reasons" (MacDonald et al., 2017).

Practically, the results of this study could lead to educating preservice teachers about the potential drawbacks of learning-style matching, and it could also inform L2 vocabulary instruction and discussions about the differences between style matching and multimodal instruction (MacDonald et al., 2017).

Study

The goal of this study is to answer four questions:

1. To what extent do learning-style preferences (auditory, visual) equate to L2 vocabulary learning *aptitudes* (as measured by listening recall and reading recall)?
2. What is the extent to which learning-style preferences (auditory, visual) predict how much L2 vocabulary an individual comprehends and retains based on *mode of instruction* (as measured by listening recall and reading recall)?
3. Which modality (auditory or visual) is the strongest predictor of scores (as measured by listening recall and reading recall)?
4. What is the extent to which education students involved in the study believe that the meshing hypothesis influences their L2 vocabulary learning?

Participants

A total of 100 adult males and females educated in a western system (i.e., WEIRD: Western, Educated, Industrialized, Rich, and Democratic) participated in the study, recruited from a university teacher education course focused on second language learning. No participants had any knowledge of Tagalog, a Filipino language (used for instruction in the present study). Participants received 5 extra credits points for the semester.

Method

Participant learning styles were first identified. Next, participants were randomized into two groups, trained with either audio or text on the same set of vocabulary, and finally tested with one measurement (Pashler et al., 2008). This study included a self-predictive test score, post-test questionnaire about the vocabulary learning experience, and a follow-up test after one week.

Materials and procedure

First, participants completed the *Barsch Learning Style Inventory (BLSI)*, a measure used in education and psychology research to investigate learning-style preferences and learning outcomes for verbal, visual, and tactile input (Krätzig & Arbuthnott, 2006; Knoll at al., 2017). The survey consisted of 24 questions about learning preferences: auditory, visual and kinesthetic. It is scored along a five-point scale, with these possible answers: *Often = 5 points; Sometimes = 3 points; and Seldom = 1 point*. The relative strength of the participants' learning-styles preferences was determined by the total points assigned to each category, and only data from those participants with a visual or auditory preference were included.

Of the 105 participants, 72 preferred visual input (69%), 28 preferred auditory input (27%), and five preferred tactile input (5%). The learning-styles preference distribution fit within reported surveys: visual preference between 50%-80% (hereafter referred to as visual learners); auditory preference between 20%-40% (from here on referred to as auditory learners); and tactile at less than 30% (Tight, 2010). We excluded kinesthetic learners from the analysis because their sample size was too small, and we did not offer kinesthetic learning-style training. Consequently, we used a total of 100 unique participants in our analysis. Data were collected over three years (2017-2020).

In order to compare whether or not learners acquire L2 vocabulary in one modality better than another when influenced by a particular learning-style, testing needs to be done on large numbers of people with words of similar length, structure, and associative features (Macedonia, 2015, p. 2). Thus, 12 Tagalog verbs were chosen. The vocabulary words were not cognates of Spanish, and all had two syllables. The words were everyday action verbs such as *read, walk,* and *eat*.

Participants were randomized and trained in one of two test groups: auditory (A) or visual (V). Both test groups received the same training script but in a different modality. Test Group A heard the words and Test Group B read the words. Participants were directed to not supplement words with writing, speaking or actions. Each word was presented for 15 seconds, for a total of about three minutes for each training block of 12 words. During the three training blocks separated by two-minute intervals, the same 12 words were introduced but in a different order.

Test Group A trained with a recorded script and heard each

audio prompt twice for 15 seconds; each word was heard six times and its definition four times. The Group A audio script adhered to the following pattern and for each word:

"The word is tayo.
Tayo *means stand up.*
Tayo *means stand up.*
Again, the word is tayo.
Tayo *means stand up.*
Tayo *means stand up."*

Test Group V trained with a timed PowerPoint presentation and read each text prompt for a total of 15 seconds; The Group V text adhered to the following pattern for each word:

The word is tayo. Tayo *means stand up."*

After a five-minute break, test groups were presented with a paper-and-pencil active recall test of the 12 vocabulary words in a different order (but in the same order for both groups). Participants wrote down their predicted scores (x/12) before testing. The A test group heard each vocabulary word narrated one-by-one and had five seconds to write down the English definition from memory alone. The V test group read each vocabulary word on the computer screen one-by-one and had 5 seconds to write down the English definition from memory alone. Participants used active recall of meaning which can be considered a more advanced degree of knowledge than recognizing definitions in a set of options (Laufer & Goldstein, 2004).

After the recall test, participants answered post-test questions about whether the training matched their preferred learning style and if this mis/match affected their learning. We used the following initial and contingent follow-up question to understand participant belief about the meshing hypothesis:

"Did your preferred learning style (auditory, visual, kinesthetic) match the vocabulary training for the 12 words? Yes or No?"

- If the participants answered *Yes*, then they answered the open-ended question "Do you think you *learned more words* than if the words were taught in a different style? Yes or no? Explain."
- If the participants answered *No*, then they answered the open-ended question "Do you think you *would have learned more words* if the words were taught in a different style? Yes or no? Explain."

We identified participants who expressed their actual or potential L2 vocabulary learning (either positively or negatively) in terms of a *single* learning-style preference and matching as *(+) meshing*. We identified those who expressed their actual or potential L2 learning (either positively or negatively) in terms of paired *multimodal* enrichment such as hearing, reading, pictures, writing down words, or iconic gestures, as *(-) meshing*. To assess participants' *beliefs* in the meshing hypothesis, we correlated data from the participants' answers on the post-test questionnaire with their preferences on the *BLSI*, assigned experimental groups, and reported style preferences.

One week later both test groups were tested over the same 12 words in a different order (but in the same order for both groups).

We employed a one-way ANOVA and T-tests for independent samples to determine whether learning-style preferences significantly differed in test results. In accordance with the literature, we expected that meshing would not occur. Auditory learners in the V test group would score the same or better than auditory learners assigned to the A test group.

Results

The results of the present study confirmed the researchers' expectations. Audio learners assigned to the A test group scored an average of 6.813 on the initial test, whereas Audio learners assigned to the V test group scored an average of 9.364 (Table 1). In contrast, Visual learners assigned to the A test group scored an average of 7.324 on the initial test, whereas Visual learners assigned to the V test group scored an average of 10.590 (Table 1).

Results from the one-way ANOVA revealed that Audio and Visual learners assigned to the V test groups scored significantly higher on the initial recall test (p-value<.001) than Visual and Audio learners in the A test groups (Figure 1). Based on the effect size (Eta-squared), 19.5% of the variance

Table 1: Descriptive Statistics of the L2 Vocabulary Learning on the Initial Recall Test

Learner Group	Test Group	N	Mean	Standard Dev.
Audio	Audio (A)	16	6.813	3.781
Audio	Visual (V)	11	9.364	3.107
Visual	Audio (A)	39	7.324	4.417
Visual	Visual (V)	34	10.590	2.381

in T1 test scores is associated with membership in the testing groups.

Although there was a 22% attrition rate in the sample on the follow-up recall test, the same pattern emerged (Figure 2), albeit with lower overall scores. Audio learners assigned to the A test group scored an average of 4.31 (n=13, SD=3.225), whereas audio learners assigned to the V test group scored an average of 7.44 (n=9, SD=3.167). In contrast, Visual learners assigned to the A test group scored an average of 4.46 (n=26, SD=3.524), whereas Visual learners assigned to the V test group scored an average of 6.47 (n=30, SD=3.026).

These results contradict the meshing hypothesis. According to the meshing hypothesis, participants who prefer audio learning styles assigned to the A test group would outperform participants who prefer visual learning styles assigned to the A test group. If this were the case, we would expect the audio learners in the A test group to have higher scores than the visual learners in the A test group. However, this is not the case. V test group scores were higher for both audio and visual learners on the initial and follow-up recall tests. These results demonstrate that no matter the learning-style preference, participants in the V test group performed better on the L2 vocabulary learning tests than participants in the A test group. In sum, no crossover interaction occurred between test groups. As reported in Pashler et al., (2008, Figure 1), "...the *same* learning method [visual] optimized the mean test score of both kinds of learners, thereby precluding the need to customize instruction."

Although assignment to the V test group was a significant predictor of participant scores, another strong predictor was participants' *predicted* scores. Before each test, the instructor asked participants to predict their scores. These predictions strongly correlate (p-value < .001) with the student's actual scores (r = .58 for A test group and r = .5 for V test group). In total, the predicted scores explained 39% of the variance of the actual scores (R2 = .393). Despite their learning-style preferences, students in the V test groups predicted significantly higher scores than students in the A test groups, on average (p-value<.001). This unexpected outcome may indicate that reading, compared to listening, has more influence on students' L2 initial vocabulary learning.

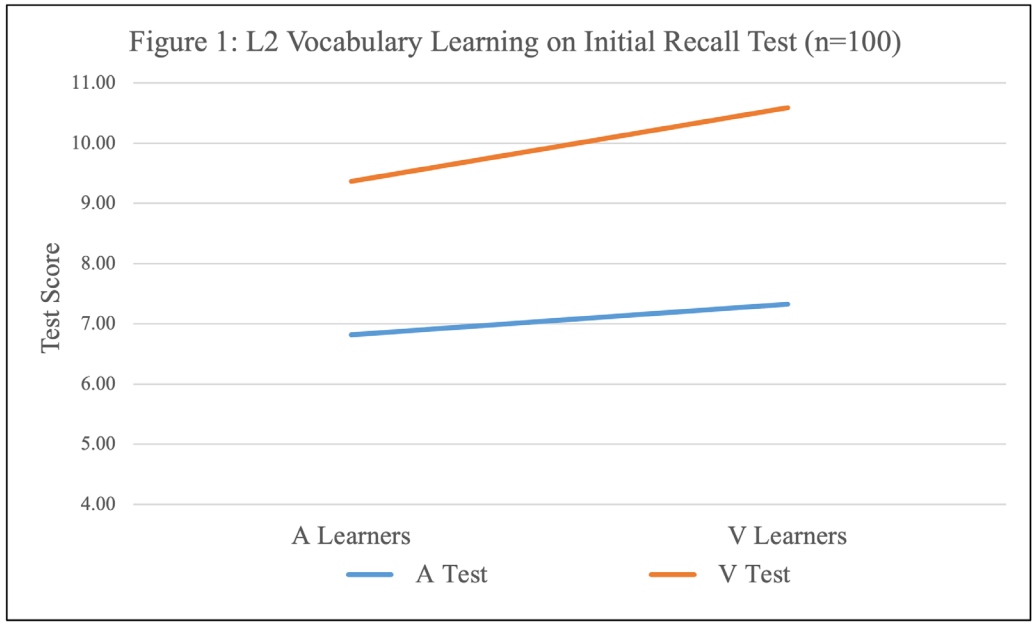
General discussion

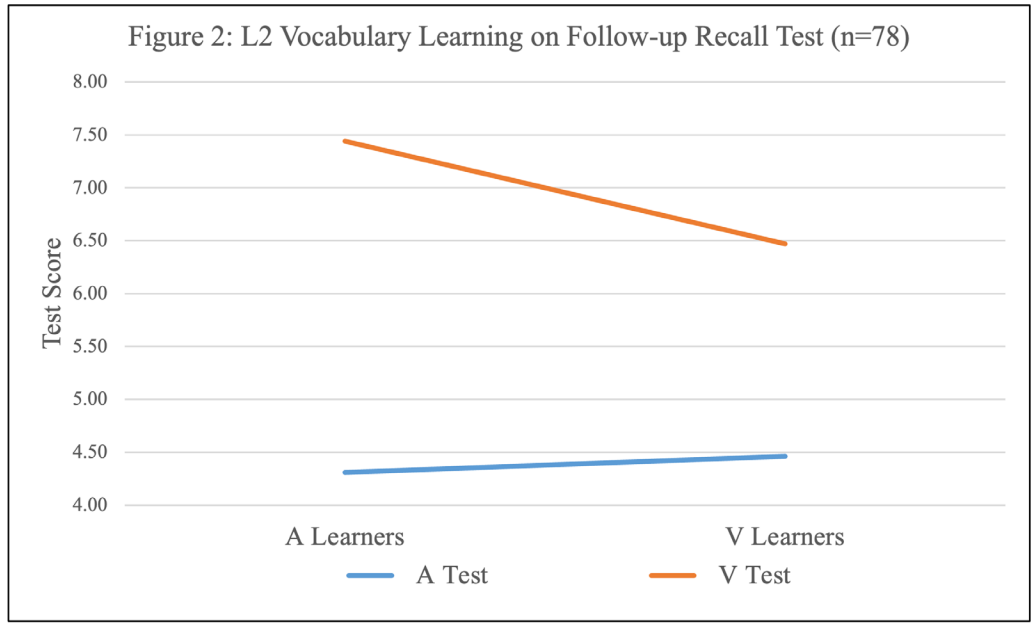
Stated learning-style preferences do not adversely affect aptitude

This study examined both quantitative and qualitative data regarding the meshing hypothesis. This study confirms a previous study's findings (Tight, 2010) that students have aptitude to learn L2 vocabulary regardless of learning-style preferences.

Reading produced more L2 vocabulary learning than listening

Regardless of learning-style preferences, the present study results indicate that visual text training produces more L2 vocabulary learning than auditory input. Visually trained





participants monitored their vocabulary learning and predicted their output with strong accuracy. One possible influence on the V test group judgement of learning is that compared to auditory input, visual input can be more easily "refreshed," rehearsed and monitored in short-term memory, then compared *after a delay* with long-term memory in later training blocks without interference from short-term memory (Dunlosky & Nelson, 1991; Holmes, 2016, p. 8). This process may also free up more attention for word association or visualization of verb activities, which some V test group participants reported in the post-test questionnaire.

Many education students wrongly assumed that meshing increases learning

In line with previous research (Macadonia, 2015), results show that an individual's assumptions about the effectiveness of style matching on instruction do not influence L2 vocabulary learning outcomes. Still, a large number of education students (57%) in the present study reported that style matching positively or negatively influenced their own L2 vocabulary learning. This belief is contrary to the empirical data which showed that there are no crossover interactions of learning styles when matched with instruction.

Pedagogical implications

MacDonald (2017) reports that persistent educator belief in learning-style based interventions "reflects the broader need to convey nuances across disciplinary boundaries of education and neuroscience to best meet the instructional and learning needs of students and educators." They recommend that in addition to the literature, educational coursework and professional development should highlight the differences between style matching and multimodal instruction. For example, teacher educators can model multimodal instruction that enriches L2 verbal vocabulary material with pictures. Verbal and visual codes are stored in different brain areas, so visual enrichment builds an expanded web of connections that strengthens and preserves vocabulary learning over time (Repetto et al., 2017). Additionally, kinesthetic input provides essential information for encoding language information and for interpreting the world. Iconic gestures paired with L2 verbal vocabulary information are stored and recalled as embodied cognition or as "body in mind" (Macedonia & Knösche, 2011), the focus of Total Physical Response (TPR) lessons. Interestingly, the WIDA Standards Framework interpretive communication modes model includes listening, reading, and viewing but omits the sensory/motor category (2020, p. 28-29).

Students may also benefit from instructional approaches based on vocabulary word type. Evidence indicates that pairing iconic gestures with concrete nouns (e.g., *bicycle, backpack*) and manipulation verbs (e.g., *hold, write*) strengthens learning while paired pictures enrich abstract verbs (e.g., *dream, think*; Repetto et al., 2017). Surprisingly, glossing L2 words with L1 definitions does not appear to improve beginning L2 vocabulary learning (Morett, 2019).

Lessons incorporating multimodal Universal Design Learning (UDL) support translanguaging (Cioè-Peña, 2022). Multilingual learners can independently utilize manipulatives, tactile vocabulary lists, assistive technology, audiotext, drawings (instead of writing), cut-ups, and sorting. Students also have the option to audio record their ideas and to transfer them into writing in L1 and/or L2.

Limitations

Participants in the present study were adults from Western, educated (literate), industrialized, rich, and democratic societies (WEIRD); children, and literate populations from oral cultures should be included in future research. The present study looked at single-modality verbal input effects only: auditory or visual. Furthermore, only one instrument (the BLSI) was used to assess style preferences. Research should continue to examine the effects of enriched input and permutations of learning styles. Other research could examine possible pathways of pre-service teachers' belief formation regarding style matching or ways to influence those belief outcomes (MacDonald, et al., 2017).

References

Barsch, J. (1991). Barsch learning style inventory. Novato, CA: Academic Therapy.

Cioè-Peña, M. (2022). TrUDL, A path to full inclusion: The intersectional possibilities of translanguaging and universal design. tesol QUARTERLY, 56(2), 799-812. https://onlinelibrary.wiley.com/doi/full/10.1002/tesq.3074

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning. A systematic and critical review. London: Learning and Skills Centre. https://www.leerbeleving.nl/wp-content/uploads/2011/09/learning-styles.pdf

Dekker, S., Howard-Jones, P., & Jolles, J. (2012). Neuromyths in education: Prevelance and predictors of misconceptions among teachers. Frontiers in Psychology: Educational Psychology, 3. https://doi.org/10.3389/fpsyg.2012.00429

Dunlosky, J., & Nelson, T. (1991). When people's judgments of learning (JOLs) are extremely accurate at predicting subsequent recall: The "delayed-JOL effect. Psychological Science, 2(4), 267-271. https://doi.org/10.1111/j.1467-9280.1991.tb00147.x

Holmes, J. D. (2016). Great myths of education and learning. Blackwell. https://doi.org/10.1002/9781118760499.ch1

Knoll, A. R., Otani, H., Skeel, R. L., & Van Horn, K. R. (2017). Learning syle, judgements of learning, and learning of verbal and visual information. Journal of British Psychology, 108, 544-563. http://doi:10.1111/bjop.12214

Krätzig, G. P., & Arbuthnott, K. D. (2006). Perceptual learning style and learning proficiency: A test of the hypothesis. Journal of Educational Psychology, 98(1), 239-246. http://doi:10.1037/0022-0663.98.1.238

Laufer, B., & Goldstein, Z. (2004). Testing vocabulary knowledge: Size, strength and computer adaptiveness. Language Learning, 54(3), 399-436. https://doi.org/10.1111/j.0023-8333.2004.00260.x

MacDonald, K., Germine, L., Anderson, L., Christoduolou, J., & McGrath, L. M. (2017). Dispelling the myth: Training in education or neuroscience decreases but does not eliminate beliefs in neuromyths. Frontiers in Psychology, 8. https://doi.org/10.3389/fpsyg.2017.01314

Macedonia, M., & Knösche, T. R. (2011). Body in mind: How gestures empower foreign language learning. Mind, Brain, and Education, 5(4), 196-211. https://onlinelibrary.wiley.com/doi/10.1111.j.1751-228x.2011.01129.x

Macedonia, M. (2015). Learning styles and vocabulary acquisition in second language: How the brain learns. Frontiers in Educational Psychology, 6. https://doi.org/10.3389/fpsyg.2015.01800

Morett, L. M. (2019). The Power of an Image: Images, not glosses, enhance learning of Concrete L2 words in beginning learners. Journal of Psycholinguistic Research, 48, 643-664. https://doi:10.1007/s10936-018-9623-2

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. Psychological Science in the Public Interest, 9(3), 106-119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

Pearson Education. (2016). Learning styles white paper. https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/efficacy-and-research/methods/LearningDesignWhitepaper_Final.pdf

Repetto, C., Pedroli, E., & Macedonia, M. (2017). Enrichment effects of gestures and pictures on abstract words in a second language. Frontiers in Psychology, 8, 2136. https://doi:10.3389/fpsyg.2017.02136

Rohrer, D., & Pashler, H. (2012). Learning styles: where's the evidence? Medical Education, 46(7), 634-635. https://doi.org/10.1111/j.1365-2923.2012.04273.x

Tight, D. G. (2010). Perceptial learning style matching and L2 vocabulary acquisition. Language Learning, 60(4), 792-833. https://doi.org/10.1111/j.1467-9922.2010.00572.x

WIDA. (2020). WIDA English language development standards framework, 2020 edition: Kindergarten–grade 12. Board of Regents of the University of Wisconsin System. WIDA. (2020). https://wida.wisc.edu/resources/wida-english-language-development-standards-framework-2020-edition

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