The Gleam-Glum Effect with Pseudo-Words:

/i/ vs /Λ/ Phonemes Carry Emotional Valence that Influences Semantic Interpretation

by

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ABSTRACT

I recently established the gleam-glum effect confirming in both English and Mandarin that words with the /i/ vowel-sound (like "gleam") are rated more emotionally positive than matched words with the /ʌ/ vowel-sound (like "glum"). Here I confirm that these vowel sounds also influence the semantic perception of monosyllabic pseudo-words. In Experiment 1, 100 participants rated 50 individual /i/ monosyllabic pseudo-words (like "zeech") as significantly more positive than 50 matched /ʌ/ pseudo-words (like "zuch"), replicating my previous findings with real words. Experiment 2 assessed the gleam-glum effect on pseudo-words using a forced-choice task. Participants ($n = 148$) were presented with the 50 pairs of pseudo-words used in Experiment 1 and tasked to guess the most likely meaning of each pseudo-word by matching them with one of two meaning words that were either extremely positive or extremely negative in affective valence (Warriner et al., 2013). I found a remarkably robust effect in which every one of the 50 pseudo-word pairs was on average more likely to have the /i/ word matched with the positive meaning word and /ʌ/ word with the negative one (exact binomial test, $p < .001$, $z = 7.94$). The findings confirm that the gleam-glum effect facilitates bootstrapping meaning of words from their pronunciations. These findings coupled with previous real word findings (Yu et al., in press), showing not only that the effect encompasses the entire English lexicon but can also be explained with an embodied facial musculature mechanism, is consistent with the idea that sound symbolism may shape vocabulary use of a language over time by influencing semantic perception.

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"Sound symbolism" refers to cases in language where pronunciation of words reflects their meaning. To illustrate, onomatopoeic words like "zip", "burp", and "bark" allow speakers to vocally mimic the referent. Other non-onomatopoeic forms of sound symbolism include ones that link pronunciation to object sharpness (Köhler, 1929) and object size (Sapir, 1929). The various forms that the sound symbolism takes on (e.g., Köhler, 1929; Patten et al., 2018; Ramachandran & Hubbard, 2001; Sapir, 1929; Tanz, 1971; Newman, 1993; Imai et al., 2008; Westbury et al., 2018; Myers-Schulz et al., 2013) and the universality of the phenomenon (e.g., Sapir, 1929; Blasi et al., 2016; Dautriche et al., 2016; Louwerse & Qu, 2017; Brown et al., 1955) have been used to argue that most cases of sound symbolism are not merely learned associations, but reflect multi-modal sensory integration as an innate mechanism for encoding and decoding meaning in language.

These arguments have been supported by observations made on children with minimal language exposure and neuroimaging data. Children in early stages of language development show sensitivity to correspondences between sound and sensory experiences. A study by Walker et al. (2010) examined preverbal infants' (average of 128 days old) sensitivity to the correspondence between auditory pitch and visuospatial height and the correspondence between auditory pitch and visual sharpness. They confirmed that infants looked significantly longer in both congruent cases when the rising and falling of a pitch was played in congruent with an animation of a ball rising and falling and an animation of a geometric shape morphing constantly between two extremities of pointedness. While multiple studies provide evidence showing that infants and children tend to match round sounding words like "bouba" to rounder shapes and sharp sounding words like "kiki" to sharper shapes (Maurer et al., 2006; Pejovic & Molnar, 2017; Ozturk et al., 2013), a meta-analysis on these studies that included data from 425 children worldwide (between the age of 4 and 38 months) confirmed that the children were moderately sensitive to the association between round sounding words and round shapes (Fort & Lammertink et al., 2018).

Neuroimaging studies support these arguments because of observations of ERP components and activities in brain regions that suggest sensory-auditory integration (e.g., Kovic et al, 2010; Arata et al., 2010; Asano et al., 2015; Aryani et al., 2019; Revill et al., 2013; Revill et al., 2014; Yang et al., 2019). For example, in a sound symbolic word learning experiment, Kovic et al. (2010) had participants in the congruent condition learn names whose pronunciations were congruent with the sharpness of referent objects (e.g., "shick" for sharp objects and "dom" for round ones) and participants in the incongruent condition learn names whose pronunciations were incongruent with the sharpness of referent objects (e.g., "shick" for round objects and "dom" for sharp ones). In the testing phase, a name was presented aurally followed by an object presented visually. Not only did the researchers observe a recognition facilitation effect for the congruent condition (i.e., shorter RT for identifying correct object), but they also observed a stronger negative wave, from the congruent condition compared to the incongruent condition, at the occipital regions 140-180 ms following presentation of objects. The researchers conclude that the early negative ERP reflected auditory-visual integration in the visual cortex.

Researchers are starting to propose theories arguing that sound symbolism plays a key role in shaping vocabularies of language users and language evolution (Adelman et al., 2018; Dingemanse et al., 2015; Christiansen & Monaghan, 2016; Perniss & Vigliocco, 2018). The main supporting evidence include observations where sound symbolism lead to boot-strapping meaning of words, which facilitates language acquisition at all stages of language development(Motamedi et al., 2020; Lockwood et al., 2016; Kantartzis et al., 2011; Parault, 2006; Parault & Schwanenflugel, 2006; Monaghan et al., 2013; Imai et al., 2008; Nygaard et al., 2009). A study conducted by Imai et al. (2008) demonstrated the facilitation effect of sound symbolism in early verb learning. In their series of experiments, they replicated past findings that 3-year-olds in the control condition fail to generalize a newly learned non-sound-symbolic verb to the same actions performed by a different actor. However, in the sound-symbolic mimetic verb condition, their 3-year-old participants performed significantly better in generalizing novel sound-symbolic verbs to the same action but different actors. In another study, Nygaard et al. (2009) provided evidence that sound-symbolism facilitates cross-linguistic vocabulary learning. Specifically, they found that participants responded faster and more accurately in identifying learned English definitions of Japanese sound symbolic words when the definitions matched the true definition of the Japanese word compared to a random definition. Overall, the argument is well summarized by Adelman et al. (2018). They stated that words that are easier to learn and use, which fit regularities of sound symbolic words, have survival advantage in usage over other words. That is, when multiple words, including one that is sound symbolic, share a definition, language users will favor the sound symbolic word over other words and use it more frequently because the sound symbolic word is easier to learn and use. Over time, the sound symbolic word will more likely persist in a language while usage of other words diminishes.

Despite increasing recognition of the role that sound symbolism plays in shaping language, the topic remains controversial among researchers. This is both because sound symbolic cases are typically regarded as odd-ball cases in language (e.g., de Saussure, 1916; Hockett, 1960; Pinker, 1999; Goldberg, 2006; Monaghan et al., 2011; Boucher et al., 2018) and because research explaining how meaning is decoded and encoded through phonemes have largely been neglected (Sidhu & Pexman, 2018). Thus, major limitations to understanding the role that sound symbolism plays in shaping language include, first of all, a lack of a sound symbolic case that is prominent and applies to large bodies of existing words, and second of all, caveat in sound symbolism literature specifying aspects of sensory experiences that are mapped onto aspects of phonemes or explanations to the formation of pathways for auditory-sensory integration.

Recently, I uncovered a sound symbolic case that addresses these two major limitations to the argument that sound symbolism shapes language over time (Yu et al., in press). The sound symbolic case I uncovered, which I named the "*gleam-glum*" effect, shows that overall, regardless of word length, words with the /i/ vowel-sound are judged as more emotionally positive than words with the/Λ/ vowel-sound. The *gleam-glum effect* encompasses the entire English lexicon (verified using the database developed by

Balota et al. in 2007) and is also observed in Mandarin (Yu et al., in press). Furthermore, I provide data supporting an embodied musculature explanation for the sound symbolic case. Specifically, by manipulating facial muscle movement, I was able to moderate the size of the *gleam-glum effect*, which shows that facial musculature similarly moderates articulation and emotion (Yu et al., in press). In summary, my recent findings both show that sound symbolism is more prominent in language than traditionally understood and provide a mechanism explaining the sound symbolic case, I add to literature supporting that sound symbolism likely shapes vocabulary of a language over time.

The goal of the current project is to test that the *gleam-glum effect* influences semantic perception and facilitates bootstrapping meaning of words from their pronunciation by extending previous real word findings to pseudo-words, which will further support that the *gleam-glum effect* as a sound symbolic effect may shape language over time. I test this in two experiments. In Experiment 1, participants provided individual ratings to monosyllabic pseudo-words that contained either the /i/ vowel-sound or the /ʌ/ vowel-sound. My hypothesis that pseudo-words with the /i/ vowel-sound will be rated as more emotionally positive than matched pseudo-words with the /ʌ/ vowel-sound was supported. In Experiment 2, participants had to match pseudo-words with their most likely meaning in a traditional forced-choice task. My hypothesis that participants will match monosyllabic /i/ pseudo-words with positive meanings and /ʌ/ pseudo-words with negative meanings at a higher than chance rate was robustly supported. The same pseudo-words from Experiment 1 were presented in matching pairs (differing only in the vowel-sound contained) alongside two meaning words that were extremely positive and extremely negative in affective valence according to the Warriner et al. (2013) database. Results from Experiment 2 show a highly robust *gleam-glum effect*. When analyzed across the pseudo-words, across the meaning words, and across participants, all analyses confirmed that participants judged the /i/ word to be the one with the positive meaning and the /ʌ/ word to be the one with the negative meaning. The findings confirm that the *gleam-glum effect* facilitates bootstrapping meaning of words from their pronunciations. These findings coupled with recent real word findings, which show the effect encompassing the entire English lexicon and provides an embodied musculature explanation to how affective valence is mapped onto phoneme, is consistent with the idea that sound symbolism may shape vocabulary use of a language over time through facilitating meaning encoding and decoding through pronunciation.

Experiment 1

Experiment 1 serves two purposes. The first purpose is to extend the *gleam-glum effect* to pseudo-words, and the second purpose is to explore whether the sound symbolic effect will still hold when the pseudo-words are rated individually and not being compared side-by-side in matched pairs. My hypothesis is that pseudo-words with the /i/ vowel-sound will be rated as more emotionally positive than matched pseudo-words with the /ʌ/ vowel-sound.

Method

Participants

Arizona State University undergraduate students participated for course credit (n = 100, 61 females, ages 18-28 years old, *M* = 19.12, *SD* = 1.48). Among them, 77 spoke

English as their first language and 13 spoke Spanish as their first language (other languages included: Chinese, Arabic, Japanese, and Tamil). The majority (55 participants) were monolingual, 34 were bilingual, 10 were trilingual, and 1 was quadrilingual. All participants provided consent before proceeding to the online survey. Only one participant reported having a language disability. Data from two participants had to be excluded for failing to follow instructions.

Materials

Participants completed an online survey rating 200 monosyllabic pseudo-words. The 200 monosyllabic pseudo-words were presented in random order, and the instruction provided was as follows: "On the following pages you will see a non-sense word on the screen. Read it out-loud. Then, give your first impression on how negative or positive you think its meaning would be if it were a real word. Respond using the following ratings on a scale: -5(most negative); -3(negative); -1(slightly negative); +1(slightly positive); +3(positive); +5(most positive)."

Pseudo-Word Pairs. The monosyllabic pseudo-words included in the survey can be divided into four types of 50 pseudo-words—each type containing a different vowel. The four types of vowels are, /i/ (as in "gleam"), /ʌ/ (as in "glum"), /uː/ (as in "gloom"), and /æ/ (as in "glam"). The two types of vowel I am interested were /i/ and /ʌ/. The two types of pseudo-words containing these vowel sounds were generated in pairs so that an /i/ pseudo-word can be paired up with an /ʌ/ pseudo-word, differing only in the vowel sound contained. The rest of the two types of pseudo-words were fillers included in the survey to prevent participants from guessing the hypotheses. To construct the pairs of pseudo-words, I first found all pairs of spelling-bodies in English that included the /ʌ/ and /i/ vowel sound so that they share an end consonant. I then kept only spelling-bodies that were feed-forward consistent, meaning that the spelling-bodies have only one possible pronunciation (Stone, Vanhoy, & Van Orden, 1997), to maximize the likelihood that participants would pronounce the pseudo-words with the /ʌ/ or /i/ vowel sound regardless of the spelling (Ziegler, Stone, & Jacobs, 1997). I then semi-randomly attached consonants in front of the spelling-bodies to produce the list of viable pseudo-words that came in the consonant-vowel-consonant form. Once all pseudo-words were generated, I then eliminated all pseudo-homophones and all pseudo-words that are common slangs (e.g., "yuck"). This resulted in 50 pairs of monosyllabic pseudo-words that are identical in pronunciation except for whether they contained the /i/ vowel sound or the /ʌ/ vowel sound in the middle (see Appendix A for a full list of the target 50 pseudo-word pairs).

Results

Linear Mixed Effects Model

I conducted a linear mixed effects analysis using the R statistical program (R Core Team, 2017) with the lme4 procedure (Bates et al., 2015). I did not include data from filler pseudo-words in this model. This analysis predicted participant *ratings* (on a scale of -5 to +5) with participant *native language* (weighted contrast coding leading to 0.47 variable weight representing English as native language and -1.53 representing all else), whether participants *read all words* aloud before providing ratings according to their self-report (weighted contrast coding leading to 0.94 variable weight representing all words have been read and -1.06 representing not all words were read), which *vowel type* was included in the pseudo-word (weighted contrast coding leading to 1 variable weight representing /i/ and -1 representing /ʌ/), and their interactions. The model also included random effects, with the assumption that the effect brought by vowel type would vary both by participant and by word. As predicted, there was a main effect of vowel type in the hypothesized direction, $\beta = 0.25$, $t(133.11) = 3.06$, $p < .01$, $d = 0.53$. In addition, the overall mean rating as indicated by the intercept was found to be significantly lower than 0 even though there were equal numbers of /i/ and /ʌ/ type words, $\beta_0 = -0.30$, $t(174.00) = -2.96$, $p < .01$, $d = -0.45$.

Paired Samples T-test

I also performed a paired sample t-test comparing valence rating differences across all pairs of /i/ and /ʌ/ words in follow-up simple effects analyses. Indeed, across all pairs, valence ratings for the pseudo-words with the /i/ vowel sound ($M = -0.05$, $SD = 0.7$) was significantly higher than the pseudo-words with the /ʌ/ vowel sound ($M = -0.53$, $SD = 0.76$), $t(49) = 4.66$, $p < .001$, $d = 0.66$. Figure 1 depicts valence ratings for the pseudo-words by the type of vowel sound the pseudo-words include.

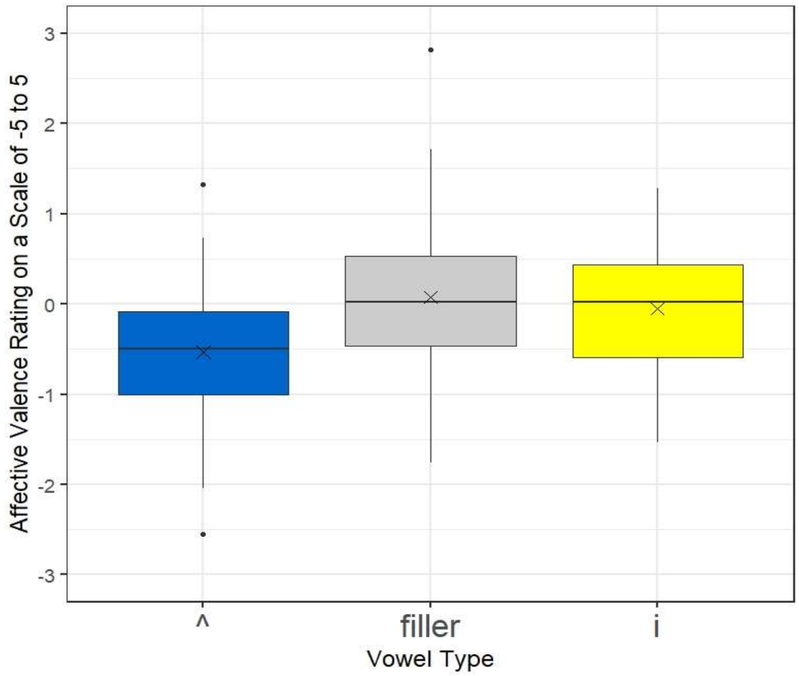

Figure 1. Boxplot of affective valence ratings across participants for all pseudo-words. All 200 pseudo-words were rated individually on a scale of -5 to 5. The choices along the scale include "-5", "-3", "-1", "1", "3", and "5". The lower and upper sides of the box correspond to the 25^{th} and 75^{th} percentiles. The end of the top and bottom whisker respectively corresponds to the largest and smallest value no further than 1.5 times the inter-quartile range. Outliers are indicated in the figure with black dots, and the "x" mark in the figure denotes mean of the distribution.

Exploratory Analyses

To further explore participants' judgment of the affective valence for the pseudo-words, I followed-up with independent samples t-tests comparing valence ratings of each the /i/ pseudo-words and the /ʌ/ pseudo-words to the valence ratings of all filler pseudo-words. As expected, valence ratings for the pseudo-words with the /ʌ/vowel sound (M = -0.53, SD = 0.76) were significantly more negative than valence ratings for the filler pseudo-words (M = 0.07, SD = 0.77), $t(98.78) = -4.59$, $p < .001$, d = -0.92. However, I did not find a significant difference between valence ratings for pseudo-words with the /i/ vowel sound (M = -0.05, SD = 0.7) and valence ratings for the filler pseudo-words (M = 0.07, SD = 0.77), $t(106.58) = -0.99$, p = ns, d = -0.19.

Discussion

Overall, my hypothesis that pseudo-words with the /i/ vowel-sound will be rated as more emotionally positive than matched pseudo-words with the /ʌ/ vowel-sound was supported. Experiment 1 provides evidence that the *gleam-glum effect* applies to pseudo-words at a medium effect size. However, my exploratory analyses supported that the overall effect seems to be driven primarily by the /ʌ/ pseudo-words while the valence rating difference between /i/ pseudo-words and filler pseudo-words failed to reach significance. While Experiment 1 demonstrates that the *gleam-glum effect* indeed influenced participant valence ratings of the pseudo-words, it is unclear that these affective valence judgments of the pseudo-words can be interpreted as semantic perception of the pseudo-words. Furthermore, because the pseudo-words were rated individually, participants' ratings were highly subject to noise introduced by other aspects of the pseudo-words. Experiment 2 uses a force-choice task where participants match pseudo-words with their most likely meanings. The force-choice task not only directly measures the influence of the *gleam-glum effect* on semantic perception, but also reduces noise by bringing out the contrasting sound symbolic effects of the /i/ and /ʌ/ phonemes.

Experiment 2

The goal of Experiment 2 is to test if the *gleam-glum effect* allows participants to boot-strap semantic meaning of "new words" they encounter using the pronunciation of these words. In force-choice tasks, participants match pseudo-words with one of two meaning words that are either extremely positive or extremely negative in affective valence (according to Warriner et al., 2013). My principal hypothesis is that participants will match /i / pseudo-words with positive meanings and /ʌ/ pseudo-words with negative meanings at a higher than chance rate. Furthermore, because the *gleam-glum effect* maps affective valence on the /i/ and /ʌ/ phonemes, my secondary hypothesis is that the *gleam-glum effect* is more reliably observed when the positive and negative meaning words have a larger difference in valence. In other words, meaning word pairs that possess a larger difference in positive versus negative valence will produce a more reliable g*leam-glum effect*.

Method

Participants

Arizona State University undergraduate students participated for course credit (n = 148, ages 18-45 years old, *M* = 19.47, *SD* = 2.49). Among them, 126 spoke English as their first language and 8 spoke Chinese as their first language (other languages included: Spanish, Arabic, Japanese, German, Indonesian, Marathi, Polish, Russian, Serbian, Turkish, and Vietnamese). The majority (85 participants) were monolingual, 54 were bilingual, 3 were trilingual, 5 were quadrilingual, and 1 was pentalingual. All participants provided consent before proceeding to the online survey. Only 1 participant reported having a language disability, and 1 participant reported having a hearing disability. Data was missing from 1 participant regarding whether the participant has a language disability or speech related disability.

Materials

Participants completed an online survey where they matched the 200 pseudo-words from Experiment 1 (100 target, 100 filler) to their most likely meanings (represented by real words). Different from Experiment 1, I presented the monosyllabic pseudo-words in pairs that differ only in the vowel being /i/ versus /ʌ/ (e.g., “bleem” versus “blum”) to allow for direct comparison. I presented pairs of meaning words, with one word having extremely positive affective valence and the other having extremely negative affective valence (e.g., “good” versus “sick”), alongside these pairs of pseudo-word. The task was to guess the most likely meaning of the pseudo-words by matching them with the meaning words.

Pseudo-Word Pairs. All 100 pseudo-word pairs used in this survey were the same as the ones used in Experiment 1. As in Experiment 1, 50 of the pseudo-word pairs were filler pairs included to distract participants from guessing the purpose of the experiment, and only the 50 /i/ and /ʌ/ pseudo-word pairs were the focus of this experiment.

Meaning Pairs. Valence ratings from the database published by Warriner et al. (2013) were referenced when compiling the list of meaning words. Corresponding to the 50 target pseudo-word pairs, only 50 meaning pairs are of interest. These 50 meaning pairs consist of one word with extremely high affective valence (above 7 on a scale of 1-9) and the other with extremely low affective valence (below 3 on a scale of 1-9). I paired the highest affective valence word with the lowest affective valence words so that, within each meaning pair, the words are similarly extreme in affect. The remaining 50 filler meaning pairs were randomly chosen from a list of neutral words (with a valence rating of 5) and randomly paired up. To ensure that definitions of the meaning words provide plausible definitions to the monosyllabic pseudo-words (e.g., definitions were simple enough), I tried to include only meaning words that were monosyllabic (For example, I excluded "compassion" even though it is extremely positive in affective valence). Because there were not enough monosyllabic meaning words that were extreme in affective valence (3 more negative meaning words and 1 more positive meaning word were needed), I had to include meaning words that were not monosyllabic. To do this, I conducted a separate survey prior to the experiment asking participants how believable they thought candidate non-monosyllabic meaning words could exist as monosyllabic words in another language (participants rated on a scale of 1 to 5; from "not believable" to "highly believable"). According to the survey results, I included "loyal", "murder", "danger", and "jealous" as the only non-monosyllabic meaning words in this experiment because they were extreme in affective valence and participants believed that they could exist as monosyllabic words in another language (see Figure 4 for all the meaning words included in the experiment).

Procedure

At the start of the experiment, participants are provided the following instruction: "Bouba is a recently discovered language. Interestingly, it seems that some people are good at guessing the meaning of words in the language. See how well you can do?! Reading aloud the Bouba words will help you do better." Figure 2 illustrates a trial of the experiment.

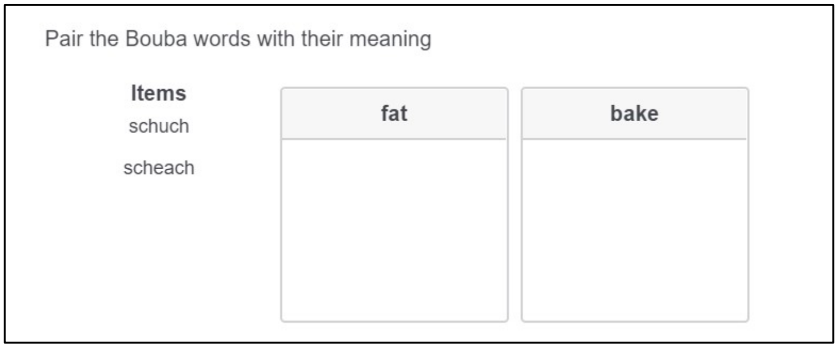

Figure 2. Illustration of a trial in Experiment 2. Participants match all 200 pseudo-words to a meaning word by dragging pseudo-words into corresponding boxes. Pseudo-word pairs of interest differ only in the vowel-sound contained. Meaning pairs contain one word that is extremely high in affective valence and another that is extremely low in affective valence.

Results

My principal hypothesis was that participants have a significantly higher probability of pairing /i/ pseudo-words with positive meanings and /ʌ/ pseudo-words with negative meanings. This was tested using a two-tailed exact binomial test to assess the *gleam-glum effect* grouping the trials by pseudo-word pairs. I also performed secondary analyses of two-tailed exact binomial tests by meaning pairs and by participants. I provide normal approximations to binomial distributions to produce z-score standard effect size measurements. Each of the 148 participants contributed 50 target trials. In analyzing the data in terms of pseudo-word pairs, I found that all 50 pseudo-word pairs showed responses in the predicted direction (depicted in Figure 3). Furthermore, 30 of the pseudo-word pairs individually reached significance above the 50% chance proportion, when only 2.5 pairs are expected to do so by chance (according to the .05 type-1error rate), $p < .001$, 95% CI [45.18%, 73.59%], $z = 7.94$.

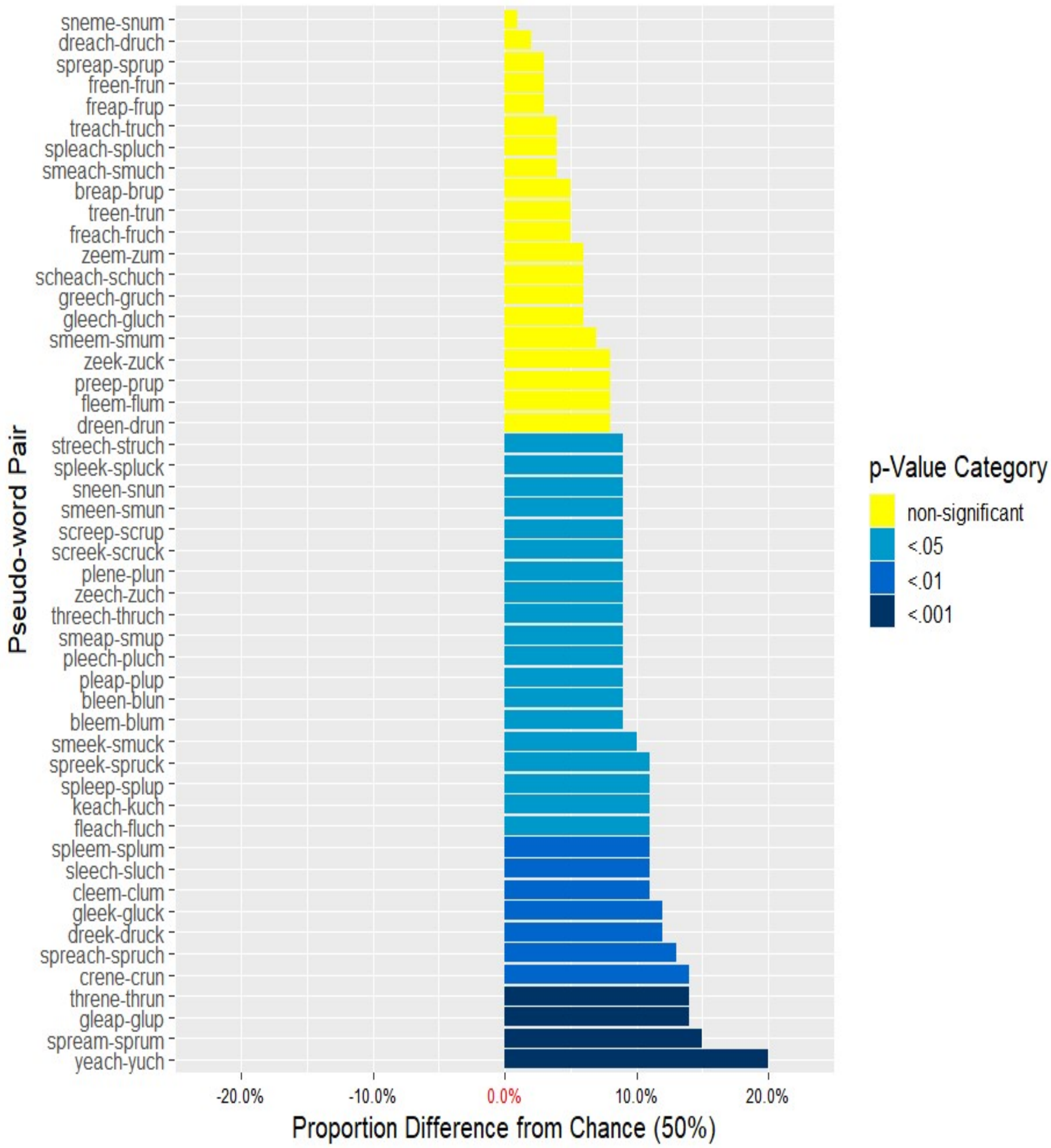

Figure 3. Bar graph of proportion of success trials for each pseudo-word pair. Binomial tests were conducted for each pseudo-word pair on their proportion of success trials compared to chance proportion (50%). The bars were ordered by the binomial test outcomes from least significant on the top (smallest proportion of success trials) to most significant on the bottom (largest proportion of success trials). Bars to the right of the 0% center point indicate pseudo-word pairs with trial responses that were overall in the predicted direction. In total, all 50 pseudo-word pairs had outcomes in the predicted direction among which 30 individually reached significance.

Analyzing the data in terms of meaning pairs, I found that 47 out of 50 meaning pairs showed responses in the predicted direction (depicted in Figure 4). Here 25 meaning pairs individually reached significance above the 50% chance proportion compared to only 2.5 expected by chance (according to the .05 type-1error rate), $p < .001$, 95% CI [35.53%, 64.47%], $z = 6.36$. Analyzing the data in terms of participants, I found that 98 out of 148 participants were biased to respond in the predicted direction. Among them, 45 participants individually reached significance above the 50% chance proportion, when only 7.5 are expected by chance (according to the .05 type-1error rate), $p < .001$, 95% CI [23.12%, 38.50%], $z = 3.05$. Overall, all when analyzed in terms of pseudo-word pairs, meaning pairs, and participants, results confirmed a highly robust *gleam-glum effect*; pseudo-words with the /i / vowel-sound were highly likely paired with positive meaning words and pseudo-words with the /ʌ/ vowel-sound were highly likely paired with negative meaning words.

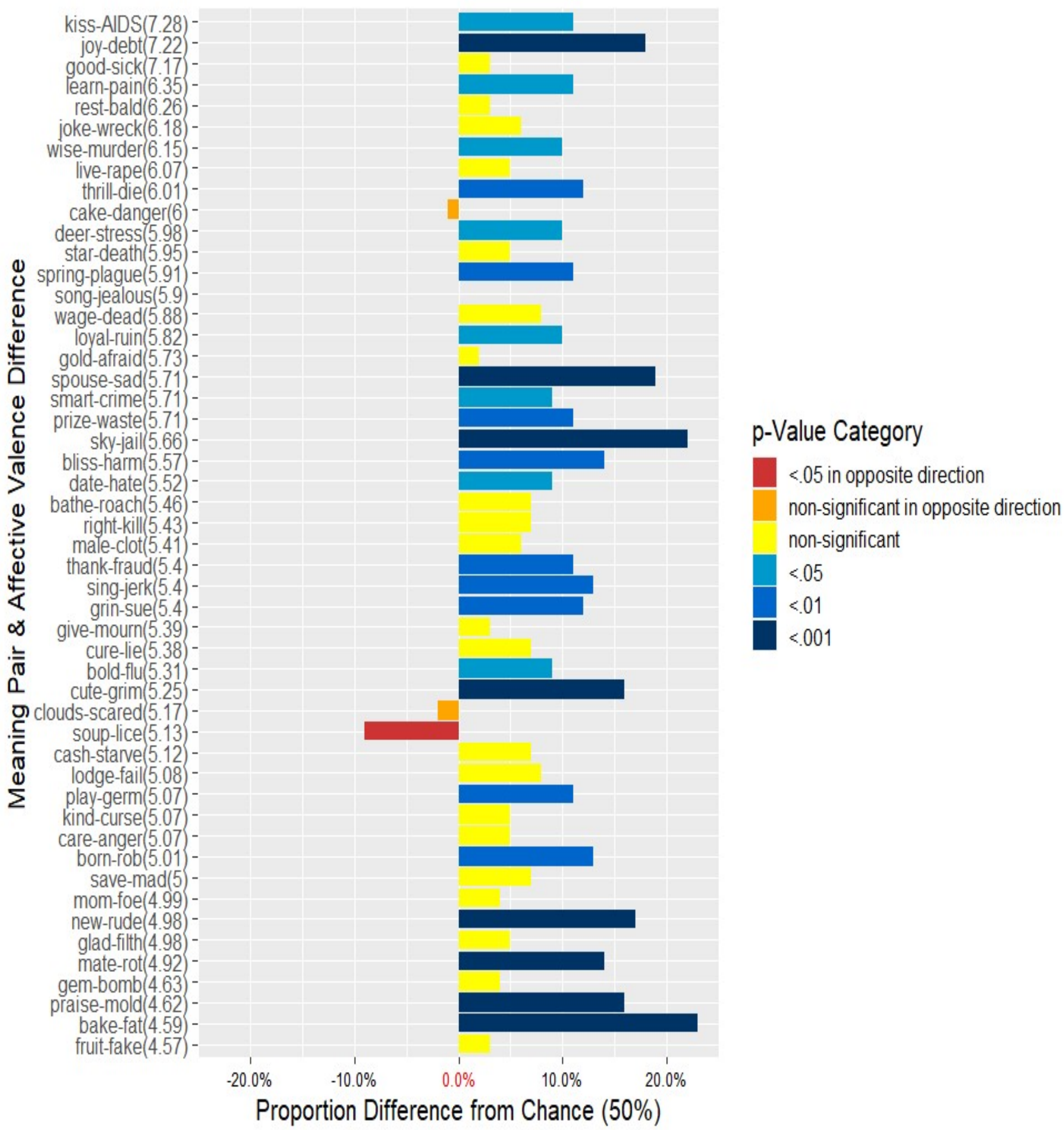

Figure 4. Bar graph showing the proportion of success trials for each meaning word pair. Binomial tests were conducted for each meaning word pair on their proportion of success trials compared to chance proportion (50%). The bars were ordered by the difference in emotional valence ratings between two meaning words of a pair (calculated using ratings retrieved from the Warriner et al. database published in 2013) from largest valence difference on the top (7.28) to smallest valence difference on the bottom (4.57). Bars to the right of the 0% center point indicate meaning word pairs with trial responses that were overall in the predicted direction. In total, 47 meaning word pairs had outcomes in the predicted direction among which 25 individually reached significance.

My secondary hypothesis was that the larger the difference in affective valence between the two words of a meaning pair, the more reliably the meaning pair will produce a *gleam-glum effect*. This hypothesis was tested with a Spearman's rank order correlation. Here, the results did not produce a significant correlation between affective valence difference of meaning pairs and proportion of success trials (r_s(21725) = -0.04, p = .77). As illustrated in Figure 4, this appears to be due to the meaning pairs overall demonstrating a reliable effect regardless of their affective valence difference. To clarify, the effect was so robust that it reliably occurred without depending on the valence rating difference so long as one meaning was negative in affect and the other positive.

Discussion

Overall, my principal hypothesis that participants will match /i / pseudo-words with positive meanings and /ʌ/ pseudo-words with negative meanings at a higher than chance rate is robustly supported. Although my secondary hypothesis that the reliability of this effect will depend on the difference in affective valence ratings between meaning words presented with the pseudo-word pairs was not supported, my analysis with trials grouped by meaning word pair confirm that the *gleam-glum effect* strongly influenced participants' semantic perception of the pseudo-word pairs regardless of with which meaning word pairs the pseudo-words were presented. Findings from Experiment 2 show that participants bootstrapped meaning of new words they encounter using /i/ and /ʌ/ phonemes and further support that the *gleam-glum effect* may shape language over time by facilitating meaning decoding and encoding through pronunciation.

General Discussion

My data confirmed my main prediction that, overall, the *gleam-glum effect* applies to pseudo-words. In Experiment 1, participants rated pseudo-words with the /i/ vowel-sound as significantly more positive than pseudo-words with the /ʌ/ vowel-sound. Similarly, in Experiment 2, participants matched /i/ type pseudo-words and /ʌ/ type pseudo-words respectively with positive meaning and negative meaning at a rate vastly significantly higher than chance. This was true when data were analyzed in terms of pseudo-word pairs, meaning pairs, and participants. This effect was highly robust and did not depend on the affective valence difference between words of a meaning pair.

It is notable that in Experiment 1 the sound symbolic effect can be observed when the pseudo-words were rated individually. Even without side-by-side comparisons of matched word-pairs that likely cause the vowel phonemes to stand out more, participants' judgments reliably produce a *gleam-glum effect,* independent of other sources of noise brought by the pseudo-words. While the results from Experiment 1 support that the *gleam-glum effect* seems largely driven by the /ʌ/ vowel sound, potential differences between valence ratings for the /i/ pseudo-words and the filler-words were not found or will require further investigation. I suggest that the forced-choice design used in Experiment 2 allows for a more powerful assessment of the *gleam-glum effect* and more directly measures how participants bootstrap meaning of the pseudo-words from their pronunciation.

Together, the two Experiments confirm that these vowel phonemes not only influenced participants' judgment of the affective valence for individual pseudo-words, but also influenced participants' semantic perception of "new words". Through testing the *gleam-glum effect* on pseudo-words, I provide more evidence that sound symbolic effects allow bootstrapping meaning of a word from its pronunciation.

The lack of a sound symbolic case that applies to large bodies of existing words (e.g., Monaghan et al., 2011; Boucher et al., 2018) and the lack of research studying mechanisms by which phonemes map sensory experiences in sound symbolic cases (Sidhu & Pexman, 2018) have been major limitations to understanding the role that sound symbolism plays in shaping language. My recent findings of the *gleam-glum effect* address these limitations by demonstrating a highly prominent sound symbolic effect that likely resulted from the integration of emotion expression and auditory via facial muscles (Yu et al., in press). The current findings then show that the *gleam-glum effect* influences judgement of pseudo-word emotional valence and that semantic meaning of the pseudo-words are bootstrapped from their pronunciation. Altogether, I provide data supporting that the *gleam-glum effect,* as a sound symbolic case, reveals innate mechanisms of meaning encoding and decoding in language and may shape vocabulary usage of a language over time by influencing semantic perception.

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APPENDIX A

TARGET PSEUDO-WORDS FOR EXPERIMENT 1 AND EXPERIMENT 2

bleem blum	gleap glup	smeach smuch	spream sprum
bleen blun	greech gruch	smeek smuck	spreap sprup
breap brup	keach kuch	smeem smum	streech struch
dreach druch	cleem clum	smeen smun	threech thruch
dreek druck	crene crun	smeap smup	treach truch
dreen drun	pleech pluch	sneme snum	threne thrun
fleach fluch	plene plun	sneen snun	treen trun
fleem flum	pleap plup	spleach spluch	yeach yuch
freach fruch	preep prup	spleek spluck	zeech zuch
freen frun	scheach schuch	spleem splum	zeek zuck
freap frup	screek scruck	spleep splup	zeem zum
gleech gulch	screep scrup	spreach spruch	
gleek gluck	sleech sluch	spreek spruck	

APPENDIX B

IRB APPROVAL

EXEMPTION GRANTED

Michael McBeath
Psychology
480/965-8930
Michael.McBeath@asu.edu

Dear Michael McBeath:

On 9/27/2017 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Understanding Phoneme Emotional Valence
Investigator:	Michael McBeath
IRB ID:	STUDY00006907
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Participant demographic information.pdf, Category: Other (to reflect anything not captured above); • Vowel Emotion Study IRB Form Draft2.docx, Category: IRB Protocol; • Phoneme Emotional Valence Consent Form Draft2.pdf, Category: Consent Form; • SONA.pdf, Category: Recruitment Materials;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 9/27/2017.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Shin-Phing Yu
Shin-Phing Yu