The Influence of Emotional Narrative Context on Word Learning

Yuzhen Dong (yuzhen.dong@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford, United Kingdom

Matthew Mak (matthew.mak@warwick.ac.uk)
Department of Psychology, University of Warwick, United Kingdom

Robert Hepach (robert.hepach@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford, United Kingdom

Kate Nation (kate.nation@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford, United Kingdom

Abstract

People learn new words in narrative contexts. Little is known about the influence of the emotional valence of the text on word learning. In a pre-registered experiment, we investigated whether emotional narrative context shapes word learning. English adults (N = 76) read 30 novel adjectives embedded in 60 short narratives (20 positive, 20 negative, and 20 neutral valence). Post-tests assessed learning (immediate and 24 hours later) and examined whether the valence of the novel words can be inferred from contextual valence. Compared to the neutral context, emotional contexts (both positive and negative) facilitated word form learning in the immediate post-tests, but only negative emotion words were recognized better 24 hours later. Furthermore, the valence of the context was reflected in the word meanings participants generated for each novel word. These findings are discussed with reference to theories of affective embodiment and its implications for supporting the learning of abstract concepts.

Keywords: Embodied Cognition; Emotion; Language Learning; Reading; Memory

Introduction

Narrative reading provides a rich and engaging medium from which people experience and learn new words (e.g., Hulme & Rodd, 2021; Mak et al., 2021). Many factors influence how well a word is learned from reading, but little is known about how the emotional content within these texts might influence word learning. In language, emotional valence refers to the pleasantness of a word and the extent of its positivity or negativity (Warriner et al., 2013). It broadens the definition of emotion words from just describing an emotional state, such as *happy* or *sad*, to all words with affective associations, such as *friendly* or *cruel*. Word valence influences how early and how well a word is learnt (e.g., Kousta et al., 2011; Ponari et al., 2020); it also influences lexical processing in adults (e.g., Vinson et al., 2013). Most existing research relies on valence norms in which people rate a familiar word for positivity (e.g., Warriner et al., 2013). For an unfamiliar novel word, however, how do people learn its valence? One possibility is from the valence of the context in which it appears. In line with this, Snefjella and Kuperman (2016) reported a positive correlation between word valence and contextual valence, defined as the aggregate valence of the five content words immediately before and immediately after the word in text samples taken from a large corpus of email newsgroup postings. Experimental work has also investigated how emotional contexts might influence language learning, but the results have been mixed.

Word valence is known to influence lexical processing. In lexical decision for example, emotional words, whether positive or negative, are processed faster and with greater accuracy than neutral words, a phenomenon that persists regardless of the mode of word presentation (Kousta et al., 2009; Ponari et al., 2018; Scott et al., 2009, 2012). Further support comes from neuroimaging and electrophysiological studies, which demonstrate that words with more extreme valence elicit distinct neural responses compared to neutral words (Pauligk et al., 2019; Vigliocco et al., 2014; Yao et al., 2016). This processing advantage extends beyond isolated words to those presented within sentences, affecting both lexical processing and memory (Bayer et al., 2010; Scott et al., 2012).

Emotional valence predicts age-of-acquisition ratings and emotionally valenced abstract words tend to be lower in age of acquisition than neutral ones (Kousta et al., 2011). Ponari et al. (2018) suggested that emotional valence provides a bootstrapping mechanism for acquiring abstract concepts. However, this valence effect is not uniformly observed across all age groups but is particularly pronounced in children aged 8 to 9 years (Lund et al., 2019; Ponari et al., 2018). Moreover, valence also impacts children's learning and memory for newly taught abstract words, with emotionally valenced words being learned better and defined more accurately than neutral words (Kim et al., 2020; Ponari et al., 2020). These findings align with the affective embodiment account which proposes that emotional content aids in grounding abstract word meanings in emotional experiences, providing a motivational relevance that heightens processing efficiency (Vigliocco et al., 2014). However, while this account suggests that emotional valence facilitates the acquisition of abstract words, it does not have clear predictions about its directionality.

There are mixed findings as to the directionality of any valence influence on word processing and learning. Some

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

studies have found a positivity advantage (e.g., Kuperman et al., 2014; Ponari et al., 2018; Yao et al., 2016), which can be explained by the Pollyanna principle, a global tendency for humans to remember pleasant things more accurately (Matlin & Stang, 1978). Unkelbach et al. (2008) proposed the informational density hypothesis, where positive information, being more elaborated and densely clustered, is processed faster than negative information. The greater interconnectivity of positive words in a denser semantic network might result in it being activated faster during word processing. Other studies, however, have also found a negativity advantage (e.g., Estes & Verges, 2008). This has been explained in terms of an increased vigilance for negative stimuli (Pratto & John, 1991) by which individuals have an intrinsic tendency to focus attention on negative stimuli. This can lead to more in-depth processing of negative information and therefore better recognition memory (Ortony et al., 1983). Similarly, the Negative Emotional Valence Enhances Recapitulation model (NEVER, Bowen et al., 2018) further highlighted the role of negative valence in enhancing the reactivation of sensory details over time, suggesting that already in early ontogeny negative events and stimuli may be encoded and retrieved with greater sensory fidelity (Vaish et al., 2008). While both positive and negative advantages have been reported, it is difficult to draw clear conclusions regarding directionality, not least because different studies use different methods and might therefore tap into different processes.

Word valence is usually determined from large-scale rating studies where participants rate the valence of individual words on a scale (e.g., Warriner et al., 2013). Affective ratings can be predicted from contextual variables such as contextual diversity (Recchia & Louwerse, 2015), and Kuhlmann et al. (2017) found that the valence of semantic neighbours within a word's associative network influences the perceived valence of neutral words, treating valence as a 'semantic super-feature'. In line with this, Snefjella and Kuperman (2016) reported a positive correlation between word valence and contextual valence, with contextual valence defined as the aggregate valence of the five content words immediately before and immediately after the word in text samples taken from a large corpus of email newsgroup postings. This suggests that words acquire a valence that reflects the overall emotional tone of the contexts in which they are used. They also found that the contextual valence of a word predicts lexical decision performance, even when the influence of word valence was controlled, reinforcing the idea that a word's contextual history influences lexical processing (Hsiao et al., 2020).

Experiments have investigated the influence of emotional context on the learning of new words. Snefjella et al. (2020) asked native speakers of English to learn nine novel nouns (e.g., plurk), each embedded in five short passages that were designed to be positive, neutral, or negative. Participants learned the form and the meaning of the novel words; the novel words also acquired emotional connotations suggesting that there was transfer of valence from contexts. Using the same paradigm, Lana and Kuperman (2023) investigated the learning of novel words that denoted abstract and concrete nouns. They found that positive contexts led to better quality of semantic learning in the definition matching task, but contextual transfer of valence was only evident for concrete nouns. While other experiments have investigated word learning while varying emotional context, findings are difficult to compare as different methods have been used. For example, Driver (2021) found better word learning when words were embedded in neutral or negative emotion-laden texts, yet Frances et al. (2020) reported a facilitative effect for words learned in positive contexts in relation to neutral contexts; note however they did not include any negative contexts. Taken together, these studies consistently show that a novel word can acquire valence from the emotional tone of its surrounding text. Less clear, however, is whether positive or negative contexts (or both) support word learning.

Existing studies have focused predominantly on nouns. Plausibly, words from other grammatical classes, such as adjectives, might show a different pattern. Compared to nouns, adjectives are more abstract, and their meanings might be more context-dependent (Davies et al., 2020; Dawson et al., 2021), so the effect of contextual valence may be more important in this word class. We therefore focused on learning novel adjectives and used a naturalistic reading procedure to investigate the effect of contextual valence on word learning, and whether people learn the valence of novel adjectives from positive, neutral, and negative context immediately after reading. We also asked how well people remembered the newly learned words 24 hours later.

Due to word limit, this report only considers two of the three hypotheses and the associated tasks.

Hypothesis 1: Participants would learn novel word form from reading short narratives in both immediate and delayed post-test, and especially in more emotional (positive and negative) contexts.

Hypothesis 2: Participants would infer the valence of novel words from the linguistic context in which they appear.

Method

Design

There was one independent variable, contextual valence, with three levels: neutral, negative, and positive. This was manipulated within-participant. Accuracy and RT were measured and served as dependent variables. The study spanned two sessions. Session 1 consisted of a reading phase and a test phase. Session 2 consisted of a test phase only and was available 24 hours after participants completed Session 1. The study, including the sample size, exclusion criteria and confirmatory analysis plan, was pre-registered ahead of data collection (https://osf.io/sc4ze).

Participants

Eighty-seven participants (42 Females, 45 Males) were recruited through Prolific and completed both sessions of the study remotely. Their ages ranged from 18 to 30 years old

(M_{age} = 25.72, SD_{age} = 3.27). All participants reported to be native English speakers based in the UK, have normal or corrected-to-normal vision, and no history of dyslexia or other language difficulties. They all provided consent before taking part. Following our pre-registered exclusion criterion, 11 participants were excluded from all the analyses due to them failing more than 20% of the attention checks. The final sample size was 76 (34 Females, 42 Males; range 19 to 30 years, M_{age} = 25.58, SD_{age} = 3.30).

Materials

We created 60 naturalistic paragraphs ($M_{word\ count}$ = 18.95, $SD_{word\ count}$ = 2.65) of either positive, neutral, or negative valence (20 paragraphs in each condition). The sentiment of each paragraph was estimated using BERT (Devlin et al., 2018 and rated by 20 native English speakers who did not take part in the main study. Both approaches showed that contextual valence differed significantly across the three paragraph types, with paragraphs in the positive condition showing the highest valence, followed by neutral, and then by negative. Paragraphs across conditions were matched for their mean length of utterance.

There were 70 novel words, 30 of which were target novel words and the others were foils. Each of the 30 target novel words was embedded twice in two paragraphs of the same valence (see Table 1 for example narratives and novel words). The novel words were 6 or 7 letters long, M = 6.63 letters, SD = 0.46. They do not have a base meaning and were created to have a nonword stem plus an adjective suffix, for example, the nonword stem "rar" and the adjective suffix "ive" led to the novel word "rarive". We chose 10 adjective suffixes from a list of suffixes with high diagnosticity values for adjectives, as calculated by Ulicheva et al. (2020). The target novel words had no orthographic neighbors, according to *NWatch* (Davis, 2005). Assignment of target novel words to the contextual valence condition was counterbalanced, where a novel word that appeared in the positive context for one participant appeared in the neutral or negative context for other participants. The foils were the same across participants.

Table 1: Example narratives in each condition

Contextual Valence	Examples
Neutral	This sopable machine was newly produced by the company. It has a sopable cover and four wheels.
Negative	I had a plarous argument with my friend today. We could not agree. Their plarous words hurt my feelings.
Positive	I am having a picial time with my family in this beautiful weather. We enjoyed the picial scenery.

Procedures

After reviewing the participant information sheet and providing consent, participants reported basic demographic data. The experiment was programmed and hosted on Gorilla (www.gorilla.sc).

(i) Reading phase. This was structured around the premise of an alien attempting to learn English who occasionally replaced English words with words from its own language when writing a diary. These served as the novel words for the purposes of the word learning experiment. Participants saw the novel words in positive, negative, or neutral paragraphs and each participants experienced 30 novel words embedded in 60 short narratives, evenly split into two blocks of 30. They were told to learn these novel words. Each block also contained five narratives that served as attention checks, where participants answered a comprehension question (in a multiple-choice format) based on the narrative they just read. Participants who failed 20% of these checks were excluded from all analyses.

(ii) Immediate test phase. Immediately after reading the narratives, word learning was assessed via speeded recognition and meaning generation. For *speeded recognition*, modelled after lexical decision, participants identified whether they had previously seen a presented letter string. Each trial began with a fixation cross displayed for 250 ms, followed by the letter strings, during which the participants pressed buttons on the keyboard to make a judgment. Accuracy and Reaction Time (RT) were recorded. Each participant responded to 60 items in total (30 target novel words & 30 foils), presented in a random order in a single block. For *meaning generation*, in each trial, participants were shown one of the 30 newly learnt words (presented in a randomized order), and they were required to type in an English word they considered to correspond with the meaning of the novel word. The words produced were cross-referenced with norms of valence for English lemmas (Warriner et al., 2013), and these values were used to assign a valence score to each response.

At the end of the session participants completed a brief questionnaire soliciting their perceptions of the experiment, their reading strategies, and any additional comments. Session 1 took around 30 minutes to complete.

(iii) Delayed test phase. Twenty-four hours later, participants completed an identical version of *speeded recognition* to Session 1. Session 2 took 10 minutes to complete.

Statistical Analyses

As set out in the pre-registration, we fitted mixed-effect models with random effects for participants and stimuli, using the lme4 package (Bates et al., 2015) in R (R Core Team, 2022). RT data for the correct trials were transformed to result in a more normal residual distribution, based on the suggestion of the Box-Cox procedure (Box & Cox, 1964), and inspection of the qqplot (Millard, 2013). For all full models DV ~ ContextualValence + (1+ ContextualValence | participant) + (1+ ContextualValence | item) that failed to

converge, the random effect structure was simplified following the suggestion of the R package 'buildmer' (Voeten, 2023). The likelihood ratio test was used to compare the full model to the reduced model to assess whether including the fixed factor ContextualValence significantly improved model fit. Unless otherwise specified, after simplification, a binary logistic mixed-effects model was adopted for the dependent variable accuracy (1 or 0) and included the fixed effect of contextual valence and by-participant and by-stimuli random intercepts. A linear mixed model was fitted to the transformed RTs, with contextual valence as the sole fixed effect, and random intercepts for participants and stimuli.

The fixed effect was contextual valence (neutral, negative, positive). This was dummy-coded, and the neutral condition served as the reference level, yielding two comparisons: neutral vs. positive and neutral vs. negative. Models were fitted using maximum likelihood estimates.

Results

Descriptive statistics are provided in Table 2.

Speeded Recognition (Session 1 & 2)

Word form learning was assessed via *speeded recognition* in both sessions. Starting with the immediate post-test data, we first computed sensitivity from raw responses to the speeded recognition task (number of hits, false alarms, correct rejection, and misses) using the *dprime* function in psycho package (Makowski, 2018). A one-sample t-test provided clear evidence that participants could distinguish learned items from foils, $M_{d'}$ = 1.49, 95% CI = [1.35, 1.63], $t(75)$ = 21.30, $p < .001$.

We then compared novel words learned across the different valence conditions. Figure 1 shows the mean recognition accuracy by contextual valence. From the likelihood ratio test, contextual valence was a significant predictor for recognition accuracy, $\chi^2(2) = 12.57$, $p = .002$. As compared to words in the neutral context (M = 0.71, SD = 0.18), participants were more accurate in recognizing words experienced in the negative context (M = 0.79, SD = 0.15) and the positive context (M = 0.76, SD = 0.17; negative vs. neutral: β = 0.44, SE = 0.13, z = 3.50, p = .001; positive vs. neutral: β = 0.28, SE = 0.12, z = 2.26, p = .02).

We also tested for the differences in RT in the three valence conditions at immediate post-test. Of all 'hit' trials (N = 1725), 24 trials (1.3%) with RTs that were >3 SDs away from the mean RT of that participant were removed. The remaining RT data were inversely transformed to provide a more normal distribution of the residuals. There was no significant effect of contextual valence on RT, $\chi^2(2) = 0.87$, $p = .65$. Compared to words appearing in the neutral context (M = 853 ms, SD = 276), there were no significant differences between novel words in the negative context (M = 835 ms, SD = 203) or the positive context (M = 835 ms, SD = 230; negative vs. neutral: β = -0.0127, SE = 0.0159, t = 0.80, p = .42); positive vs. neutral: β = -0.0132, SE = 0.016, t = 0.82, p = .41).

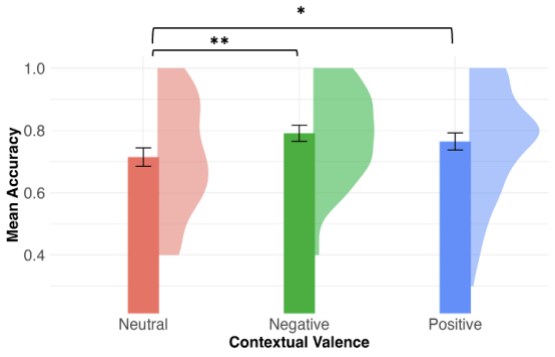

Figure 1: Plot[2] of recognition accuracy per participant by contextual valence (Session 1).

Mirroring the findings from the immediate recognition test in Session 1, there was evidence that participants could distinguish learned items from foils in the delayed recognition test, $M_{d'}$ = 1.63, 95% CI = [1.50, 1.75], $t(75)$ = 25.5, $p < .001$.

Accuracy data are shown in Figure 2. The fixed factor contextual valence is marginally significant, $\chi^2(2) = 5.81$, p = .05. Compared to words in the neutral context (M = 0.78, SD = 0.15), participants were more accurate in recognizing words experienced in the negative context (M = 0.82, SD =

Table 2: Descriptive statistics (mean and standard deviation) of various tasks.

Task	Speeded Recognition (Session 1)		Meaning Generation (Session 1)	Speeded Recognition (Session 2)	
Variable[1]	Accuracy	RT (ms)	Valence score	Accuracy	RT (ms)
Neutral	0.71 (0.18)	853 (276)	5.62 (0.63)	0.78 (0.15)	831 (341)
Negative	0.79 (0.15)	835 (203)	4.89 (0.73)	0.82 (0.15)	826 (315)
Positive	0.76 (0.17)	835 (230)	5.98 (0.69)	0.80 (0.16)	832 (346)

[1] RT is measured in millisecond; Accuracy is a probability from 0-1; Valence score is continuous value between 1-9, higher values indicate greater positivity, and lower values indicate greater negativity.

[2] The density plots represent the distribution of the mean accuracy. Error bars represent 95% within-participant Confidence Intervals. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$.

0.15), β = 0.33, *SE* = 0.14, *z* = 2.43, *p* = .02. There was no difference between learning in the positive (*M* = 0.80, *SD* = 0.16) and neutral condition, β = 0.18, *SE* = 0.13, *z* = 1.37, *p* = .17).

Of all hit trials (*N* = 1824), 39 (2.1%) had an RT > 3 SDs away from the participant's mean RT and were hence removed. The fixed effect of contextual valence was not significant, $\chi^2(2) = 0.86$, *p* = .65. Compared to words appearing in neutral valence paragraphs (*M* = 831 ms, *SD* = 341), there were no significant differences between RT towards novel words in the negative context (*M* = 826 ms, *SD* = 315) or the positive context (*M* = 832 ms, *SD* = 346; negative vs. neutral: β = -0.015, *SE* = 0.016, *t* = 0.92, *p* = .36); positive vs. neutral: β = -0.0053, *SE* = 0.016, *t* = 0.33, *p* = .74).

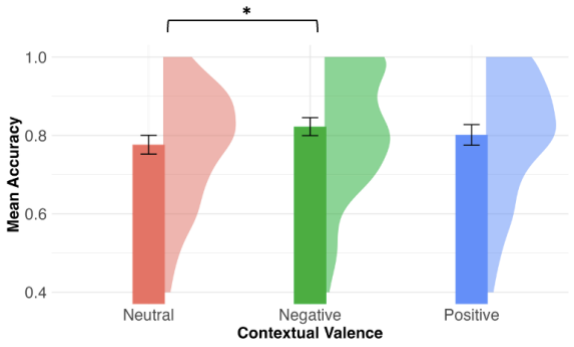

Figure 2: Plot of recognition accuracy per participant by contextual valence (Session 2).

Thus, the results of *speeded recognition* supported Hypothesis 1 that participants can learn novel word forms from reading short narratives, as indexed by the above-chance sensitivity in distinguished learned items from foils in both sessions. Participants were more accurate in emotional (positive and negative) contexts in Session 1, and more accurate only in the negative context in Session 2.

Meaning Generation (Session 1)

1934 out of 2280 (84.8%) responses had associated valence scores listed in Warriner et al.'s (2013) norms. Potential reasons for the absence of associated valence included random letter strings, "?", more than one word, or the response word was not normed. Figure 3 shows the mean valence score of generated meaning per participant by contextual valence. We built a linear mixed model with the valence score as the dependent variable and included the fixed effect of contextual valence and a by-item random slope and random intercepts. The likelihood ratio test shows that contextual valence was a significant predictor of estimated valence scores, $\chi^2(2) = 33.99$, *p* < .001. Compared to novel words appearing in the neutral context (*M* = 5.62, *SD* = 0.63), participants assigned more negative meanings to novel words experienced in the negative context (*M* = 4.89, *SD* = 0.73), and more positive meanings to novel words experienced in the positive context (*M* = 5.98, *SD* = 0.69; negative vs. neutral: β = -0.72, *SE* = 0.15, *t* = -4.66, *p* < .001; positive vs. neutral: β = 0.36, *SE* = 0.12, *t* = 2.98, *p* = .003).

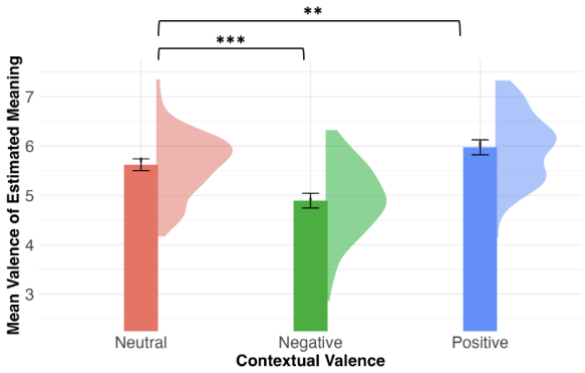

Figure 3: Plot of mean valence scores of generated meanings per participant by contextual valence.

Discussion

Our study examined if and how emotional contexts, varying in valence, influence the learning of novel words, and whether word valence can be inferred from contextual valence. Participants learned novel words embedded in short narrative contexts of either positive, neutral, or negative valence. We found that across the different contexts, participants were able to distinguish target novel words from foils, both in the immediate and delayed post-tests. As compared to words learned in the neutral context, participants were more accurate in recognizing word forms learned in the negative context (in both sessions) and the positive context (only in Session 1). We also found that people inferred the valence of novel words from the linguistic context in which they appeared, where the valence of generated words reflected the relative emotional valence of the contexts in which the novel words appeared.

Our findings that participants estimated the valence of novel words after brief exposure aligned with existing research. Following the corpus finding that contextual valence correlates with word valence (Snefjella & Kuperman, 2016) and the suggestion that the valence of the word might be inferred from its context, Snefjella et al. (2020) and Lana and Kuperman (2023) provided initial experimental evidence for the transfer of valence to novel concrete nouns. Our study supports and extends this finding to adjectives, which tend to be more abstract and emotionally charged. Furthermore, while both Snefjella et al. (2020) and Lana and Kuperman (2023) used a valence rating task to elicit participants' ratings, our study employed a novel task that did not probe valence directly, but instead asked people to provide the novel word meaning in one word. We then obtained the valence of the estimated meaning from existing norms. Participants were therefore unaware of the aim of the experiment when they were doing the task, as seen in the results of the exploratory question post-Session 1. Thus, even without explicit awareness of the influence of emotional

valence, our study still provided evidence for the transfer of valence from contexts to novel adjectives. The successful inference of novel word valence from contexts supports the affective embodiment account and has implications for language acquisition for abstract words, which often rely on emotional cues for meaning since they lack direct sensorimotor connections (e.g., Borghi et al., 2017; Kousta et al., 2011; Ponari et al., 2018). The grounding in affect allows for the development of lexical representations from linguistic rather than physical experiences.

Our results suggested that both novel word forms can be learned from reading short paragraphs. Participants showed above-chance sensitivity to distinguish learned items from foils in both immediate and delayed *speeded recognition*. This corroborates previous research showing that even a few encounters with a novel word during paragraph reading may result in fairly robust word-form learning (e.g., Mak et al., 2021). We found that participants were more accurate in recognizing words learned in emotional context (both negative and positive) in the immediate post-test. This provides further evidence for the affective embodiment account for meaning acquisition and the role of emotional valence in providing an embodied learning experience in which to anchor abstract meanings (Ponari et al., 2018, 2020; Snefjella et al., 2020). From this view, the emotional content of the context aids in grounding abstract word meanings in emotional experiences, and this is stored in semantic memory alongside the novel word's meaning and form. Our study focused specifically on adjectives, which tend to be more abstract than nouns and therefore perhaps more dependent on emotional cues that offer a grounding that would otherwise be unavailable from sensorimotor experiences.

We found that after a 24-hour delay, only words learned in the negative context were recognized more accurately compared to words learned in the neutral context. While not part of the formal hypothesis, the sustained negativity advantage suggested that negative information tended to yield better recognition memory than positive information (Ortony et al., 1983). The NEVER model (Bowen et al., 2018) highlights the role of negative valence in enhancing the reactivation of sensory details, suggesting that negative events may be encoded and retrieved with greater sensory fidelity (Vaish et al., 2008). In relation to the information density hypothesis which suggests a positivity advantage (Unkelbach et al., 2008), a one-day delay and the brief two-time exposure in our study might not be sufficient for novel words in the positive condition to become integrated into the existing lexicon. In comparison, Snefjella et al. (2020) and Lana and Kuperman (2023) found a consistent positivity advantage for newly learned words, but this was after five exposure opportunities and across a one-week interval. The amount of exposure and its time course might explain differences across studies.

Another possible explanation might be due to the to-be-learned words being adjectives. Compared to nouns, adjectives are more robustly associated with valence-dependent mutation, suggesting that the meanings of negative adjectives are more differentiated because there are more of them, and they are acquired at a faster rate (Jackson et al., 2023). We might therefore be more adapted to learning novel negative adjectives than negative nouns. Moreover, adjectives tend to have more extreme emotional valence and be more context-dependent than nouns (Davies et al., 2020; Dawson et al., 2021). Relatedly, it is worth noting that the narrative contexts were not as strictly controlled across conditions as in the study by Snefjella et al. (2020) and Lana and Kuperman (2023), which used sentences that were closely matched in syntax across conditions. While having the same sentence structure is difficult to achieve across narratives, especially considering the use of diary excerpts in our study, we closely matched the mean length of utterances and the complexity of the words used in each context. Future research might seek to tease apart the potential influence of various dimensions of emotions in language. For example, we did not control separately for arousal, which might influence learning, as neutral narratives might have lower arousal compared to positive and negative ones.

Research on the influence of emotional context in word learning is still in its early stage and mainly targets adults. There are not any known studies that investigate how children learn emotional properties of new words from reading. As children experience emotional language through reading emotional narratives, reading provides opportunities to learn new words and abstract concepts. Known valence of existing words can influence word processing and learning in children, which is moderated by age, concreteness, and other linguistic variables (e.g., Ponari et al., 2018). While younger children show a positivity advantage, this effect appears to dissipate with age (Bahn et al., 2017; Ponari et al., 2018). Hence, it would be interesting to extend the current paradigm to a developmental sample, and to see whether children can learn new words from reading short narratives, and whether they show a similar performance.

Overall, our study builds on existing research to investigate the influence of emotional context on word learning and extends it to naturalistic reading, and to adjectives. Our results demonstrated that two encounters of a novel word during paragraph reading leads to fairly robust word-form learning, especially for words learned in the emotional contexts. People also learned the valence of novel words from the linguistic context in which they appeared, which holds implications for how emotional knowledge builds during language acquisition.

References

Bahn, D., Vesker, M., García Alanis, J. C., Schwarzer, G., & Kauschke, C. (2017). Age-Dependent Positivity-Bias in Children's Processing of Emotion Terms. *Frontiers in Psychology*, *8*. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01268

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*, 1–48. https://doi.org/10.18637/jss.v067.i01

Bayer, M., Sommer, W., & Schacht, A. (2010). Reading emotional words within sentences: The impact of arousal and valence on event-related potentials. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, *78*(3), 299–307. https://doi.org/10.1016/j.ijpsycho.2010.09.004

Borghi, A. M., Binkofski, F., Castelfranchi, C., Cimatti, F., Scorolli, C., & Tummolini, L. (2017). The challenge of abstract concepts. *Psychological Bulletin*, *143*(3), 263.

Bowen, H. J., Kark, S. M., & Kensinger, E. A. (2018). NEVER forget: Negative emotional valence enhances recapitulation. *Psychonomic Bulletin & Review*, *25*(3), 870–891. https://doi.org/10.3758/s13423-017-1313-9

Box, G. E., & Cox, D. R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, *26*(2), 211-243

Davies, C., Lingwood, J., & Arunachalam, S. (2020). Adjective forms and functions in British English child-directed speech. *Journal of Child Language*, *47*(1), 159–185. https://doi.org/10.1017/S0305000919000242

Davis, C. J. (2005). N-Watch: A program for deriving neighborhood size and other psycholinguistic statistics. *Behavior Research Methods*, *37*(1), 65–70. https://doi.org/10.3758/BF03206399

Dawson, N., Hsiao, Y., Tan, A. W. M., Banerji, N., & Nation, K. (2021). Features of lexical richness in children's books: Comparisons with child-directed speech. *Language Development Research*, *1*(1), Article 1. https://doi.org/10.34842/5we1-yk94

Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. *arXiv preprint arXiv:1810.04805*.

Driver, M. (2021). EMOTION-LADEN TEXTS AND WORDS: THE INFLUENCE OF EMOTION ON VOCABULARY LEARNING FOR HERITAGE AND FOREIGN LANGUAGE LEARNERS. *Studies in Second Language Acquisition*, 1–24. https://doi.org/10.1017/S0272263121000851

Estes, Z., & Verges, M. (2008). Freeze or flee? Negative stimuli elicit selective responding. *Cognition*, *108*(2), 557–565. https://doi.org/10.1016/j.cognition.2008.03.003

Frances, C., Bruin, A. de, & Duñabeitia, J. A. (2020). The effects of language and emotionality of stimuli on vocabulary learning. *PLOS ONE*, *15*(10), e0240252. https://doi.org/10.1371/journal.pone.0240252

Hulme, R. C., & Rodd, J. M. (2021). Learning new word meanings from story reading: The benefit of immediate testing. *PeerJ*, *9*, e11693. https://doi.org/10.7717/peerj.11693

Jackson, J. C., Lindquist, K., Drabble, R., Atkinson, Q., & Watts, J. (2023). Valence-dependent mutation in lexical evolution. *Nature Human Behaviour*, *7*(2), 190-199.

Kim, J. M., Sidhu, D. M., & Pexman, P. M. (2020). Effects of Emotional Valence and Concreteness on Children's Recognition Memory. *Frontiers in Psychology*, *11*, 615041. https://doi.org/10.3389/fpsyg.2020.615041

Kousta, S.-T., Vigliocco, G., Vinson, D. P., Andrews, M., & Del Campo, E. (2011). The representation of abstract words: Why emotion matters. *Journal of Experimental Psychology: General*, *140*(1), 14–34. https://doi.org/10.1037/a0021446

Kousta, S.-T., Vinson, D. P., & Vigliocco, G. (2009). Emotion words, regardless of polarity, have a processing advantage over neutral words. *Cognition*, *112*(3), 473–481. https://doi.org/10.1016/j.cognition.2009.06.007

Kuhlmann, M., Hofmann, M. J., & Jacobs, A. M. (2017). If You Don't Have Valence, Ask Your Neighbor: Evaluation of Neutral Words as a Function of Affective Semantic Associates. *Frontiers in Psychology*, *8*. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00343

Kuperman, V., Estes, Z., Brysbaert, M., & Warriner, A. B. (2014). Emotion and language: Valence and arousal affect word recognition. *Journal of Experimental Psychology. General*, *143*(3), 1065–1081. https://doi.org/10.1037/a0035669

Lana, N., & Kuperman, V. (2023). Learning concrete and abstract novel words in emotional contexts: Evidence from incidental vocabulary learning. *Language Learning and Development*, *20*(2), 158-173. https://doi.org/10.1080/15475441.2023.2246438

Lund, T. C., Sidhu, D. M., & Pexman, P. M. (2019). Sensitivity to emotion information in children's lexical processing. *Cognition*, *190*, 61–71. https://doi.org/10.1016/j.cognition.2019.04.017

Mak, M. H., Hsiao, Y., & Nation, K. (2021). Anchoring and contextual variation in the early stages of incidental word learning during reading. *Journal of Memory and Language*, *118*, 104203.

Makowski, D. (2018). The psycho Package: An Efficient and Publishing-Oriented Workflow for Psychological Science. *Journal of Open Source Software*, *3*(22), 470. https://doi.org/10.21105/joss.00470

Matlin, M. W., & Stang, D. J. (1978). *The Pollyanna principle. Selectivity in language, memory, and thought.* Cambridge, MA: Schenkman.

Millard, S. P. (2013). *EnvStats: an R package for environmental statistics*. Springer Science & Business Media.

Ortony, A., Turner, T. J., & Antos, S. J. (1983). A puzzle about affect and recognition memory. *Journal of Experimental Psychology: Learning, Memory, and*

Cognition, *9*(4), 725–729. https://doi.org/10.1037/0278-7393.9.4.725

Pauligk, S., Kotz, S. A., & Kanske, P. (2019). Differential Impact of Emotion on Semantic Processing of Abstract and Concrete Words: ERP and fMRI Evidence. *Scientific Reports*, *9*(1), Article 1. https://doi.org/10.1038/s41598-019-50755-3

Ponari, M., Norbury, C. F., & Vigliocco, G. (2018). Acquisition of abstract concepts is influenced by emotional valence. *Developmental Science*, *21*(2), e12549. https://doi.org/10.1111/desc.12549

Ponari, M., Norbury, C. F., & Vigliocco, G. (2020). The role of emotional valence in learning novel abstract concepts. *Developmental Psychology*, *56*(10), 1855–1865. https://doi.org/10.1037/dev0001091

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology*, *61*(3), 380–391. https://doi.org/10.1037/0022-3514.61.3.380

R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.r-project.org/

Rayson, P., Wilson, A., & Leech, G. (2002). Grammatical word class variation within the British National Corpus Sampler. In *New Frontiers of Corpus Research* (pp. 295–306). Brill. https://doi.org/10.1163/9789004334113_020

Recchia, G., & Louwerse, M. M. (2015). Reproducing affective norms with lexical co-occurrence statistics: Predicting valence, arousal, and dominance. *Quarterly Journal of Experimental Psychology*, *68*(8), 1584–1598. https://doi.org/10.1080/17470218.2014.941296

Scott, G. G., O'Donnell, P. J., Leuthold, H., & Sereno, S. C. (2009). Early emotion word processing: Evidence from event-related potentials. *Biological Psychology*, *80*(1), 95–104. https://doi.org/10.1016/j.biopsycho.2008.03.010

Scott, G. G., O'Donnell, P. J., & Sereno, S. C. (2012). Emotion words affect eye fixations during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(3), 783–792. https://doi.org/10.1037/a0027209

Snefjella, B., & Kuperman, V. (2016). It's all in the delivery: Effects of context valence, arousal, and concreteness on visual word processing. *Cognition*, *156*, 135–146. https://doi.org/10.1016/j.cognition.2016.07.010

Snefjella, B., Lana, N., & Kuperman, V. (2020). How emotion is learned: Semantic learning of novel words in emotional contexts. *Journal of Memory and Language*, *115*, 104171. https://doi.org/10.1016/j.jml.2020.104171

Ulicheva, A., Harvey, H., Aronoff, M., & Rastle, K. (2020). Skilled readers' sensitivity to meaningful regularities in English writing. *Cognition*, *195*, 103810. https://doi.org/10.1016/j.cognition.2018.09.013

Unkelbach, C., Fiedler, K., Bayer, M., Stegmüller, M., & Danner, D. (2008). Why positive information is processed faster: The density hypothesis. *Journal of Personality and Social Psychology*, *95*(1), 36–49. https://doi.org/10.1037/0022-3514.95.1.36

Vaish, A., Grossmann, T., & Woodward, A. (2008). Not all emotions are created equal: The negativity bias in social-emotional development. *Psychological Bulletin*, *134*(3), 383–403. https://doi.org/10.1037/0033-2909.134.3.383

Vigliocco, G., Kousta, S.-T., Della Rosa, P. A., Vinson, D. P., Tettamanti, M., Devlin, J. T., & Cappa, S. F. (2014). The neural representation of abstract words: The role of emotion. *Cerebral Cortex (New York, N.Y.: 1991)*, *24*(7), 1767–1777. https://doi.org/10.1093/cercor/bht025

Vinson, D., Ponari, M., & Vigliocco, G. (2014). How does emotional content affect lexical processing?. *Cognition & Emotion*, *28*(4), 737-746. https://doi.org/10.1080/02699931.2013.851068

Voeten, C. C. (2023). *Using 'buildmer' to automatically find & compare maximal (mixed) models*. https://cran.r-project.org/web/packages/buildmer/vignettes/buildmer.html

Warriner, A. B., Kuperman, V., & Brysbaert, M. (2013). Norms of valence, arousal, and dominance for 13,915 English lemmas. *Behavior Research Methods*, *45*(4), 1191–1207. https://doi.org/10.3758/s13428-012-0314-x

Yao, Z., Yu, D., Wang, L., Zhu, X., Guo, J., & Wang, Z. (2016). Effects of valence and arousal on emotional word processing are modulated by concreteness: Behavioral and ERP evidence from a lexical decision task. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, *110*, 231–242. https://doi.org/10.1016/j.ijpsycho.2016.07.499