Journal of Child Language (2023), 1–13
doi:10.1017/S0305000923000569

CAMBRIDGE UNIVERSITY PRESS

BRIEF RESEARCH REPORT

The Development of Abstract Word Meanings

Emiko J. MURAKI[1,†], Lorraine D. REGGIN[1,†], Carissa Y. FEDDEMA[1] and Penny M. PEXMAN[2]

[1]University of Calgary, Calgary, AB, Canada
[2]University of Western Ontario, London, ON, Canada
Corresponding author: Emiko J. Muraki; Email: ejmuraki@ucalgary.ca
†These authors contributed equally to this work.

(Received 15 December 2022; revised 08 September 2023; accepted 11 September 2023)

Abstract

Extensive research has shown that children's early words are learned through sensorimotor experience. Thus, early-acquired words tend to have more concrete meanings. Abstract word meanings tend to be learned later but less is known about their acquisition. We collected meaning-specific concreteness ratings and examined their relationship with age-of-acquisition data from large-scale vocabulary testing with children in grade 2 to college age. Earlier-acquired meanings were rated as more concrete while later-acquired meanings as more abstract, particularly for words typically considered to be concrete. The results suggest that sensorimotor experiences are important to early-acquired word meanings, and other experiences (e.g., linguistic) are important to later-acquired meanings, consistent with a multi-representational view of lexical semantics.

Keywords: lexical semantics; age-of-acquisition; concreteness; abstract vocabulary development

The development of abstract word meanings

Children start using words around their first birthday and continue learning new words every day. How children learn the meanings of these words has been the subject of much philosophical and experimental interest. The role of embodied cognition, or the impact of the child's sensorimotor experience, to ground or support word learning has gained increasing attention (Pexman, 2019). However, the acquisition of abstract words, like *truth* and *about,* that do not have a perceptual referent are a challenge for embodied theories of language acquisition (Borghi et al., 2017). Abstract concepts have typically been defined in an oversimplistic manner, focusing on what they are not (i.e., not concrete, not learned through sensorimotor experience; Barsalou, 2020). Additional study of abstract word characteristics can elucidate a better understanding of how they are both acquired and represented, thereby informing theory, as well as providing insights to inform learning and clinical practice.

Andrews et al. (2009) proposed that all concepts are represented, and by extension acquired, through support from sensory, motor, and emotion experiences as well as linguistic knowledge. It is proposed that concrete words may be acquired sooner than more

experientially complex abstract concepts (Buccino et al., 2019). Indeed, Ponari, Norbury and Vigliocco (2018) analyzed age-of-acquisition (AoA) ratings and confirmed that abstract words are, on average, acquired later than concrete words. Ponari and colleagues tested these hypotheses both through subjective ratings and experimentally through a lexical decision task with children aged 6-7, 8-9, and 10-11 years. They found that for children under the age of four, less than 10% of their vocabulary consisted of abstract words but by age 12 abstract words had increased to more than 40% of their vocabulary.

Piaget (1952) postulated that first concepts emerge from infants' sensorimotor experience with their environment, and this is supported by evidence from developmental studies (Pereira et al., 2014; Yu & Smith, 2012). The impact of sensorimotor grounding on semantic representation has been well studied – however, a growing number of researchers have suggested that the multi-representational view offers a better understanding of word meaning. Multi-representational views of conceptual representation propose that sensorimotor and other experiences (emotion, social, interoception), in addition to language experience, contribute to word meaning representation (Banks et al., 2021; Borghi et al., 2019; Dove, 2011; Howell et al., 2005; Vigliocco et al., 2009). The addition of a linguistic component is proposed to help explain the acquisition and grounding of abstract concepts which by definition are not perceptible in the environment. In the developmental literature, there is evidence from recent research that words are learned through a combination of experiential input including sensorimotor (Pereira et al., 2014; Yu & Smith, 2012), emotion (Lund et al., 2019; Nook et al., 2020; Ponari, Norbury, & Vigliocco, 2018; Ponari et al., 2020; Reggin et al., 2021), socialness (Borghi et al., 2019), and interoception (Reggin et al., 2021). There is also the suggestion of a developmental trade-off, where sensorimotor information is important for early learning of word meaning and then linguistic experience becomes more important with age, enabling acquisition of more abstract meanings (Howell et al., 2005; Lund et al., 2019) but there is a paucity of evidence to evaluate this proposal (Ponari, Norbury, Rotaru, et al., 2018; Reggin et al., 2021). There is little consensus on how language experience influences vocabulary learning. Hills et al. (2010) examined the associative structure of language and found that a word's contextual diversity, as measured by the word's co-occurrence in caregiver speech, and previously known words in the child's speech (called the 'lure of associates') support language growth.

An examination of the developmental trajectory of the meanings of words provides an additional lens with which to evaluate the mechanisms of vocabulary acquisition. As mentioned, concrete words tend to be acquired before abstract words, and this difference is taken as evidence that sensorimotor experience is important to early vocabulary acquisition. However, a small set of abstract words is acquired early in acquisition. Reggin et al. (2021) found that children present with knowledge of a variety of abstract words before age 3, including several that do not have associated emotion information. Notably, of the 96 abstract words in the database examined, none were nouns. Instead, children's early acquired abstract words were closed-class words including determiners (e.g., the, all), conjunctions (e.g., and, or), prepositions (e.g., for, with), exclamations (e.g., yes, bye), and pronouns (e.g., this, they); as well as open class words including adverbs (e.g., there, why), adjectives (e.g., yucky, careful), and verbs (e.g., be, like).

What is not known is how abstract meanings are acquired. Wauters et al. (2003) studied the mode of acquisition (perceptual vs linguistic) in which children learn words. A perceptually-acquired word is learned from the physical environment whereas a linguistically-acquired word cannot be observed in the environment so the child learns the meaning of the word through language (hearing or reading). Words can also be learned through a combination of both perceptual and linguistic information and mode of

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

acquisition is therefore on a continuum. In their study, they extracted 566 words from elementary school texts. They asked adult participants to rate the words on a continuum from perceptually acquired (1) to linguistically acquired (5). Words in the early texts were judged to be perceptually acquired and words in later texts to be linguistically acquired. Further, Nook et al. (2020) tracked the developmental trajectories of 24 emotion words in a cross-sectional sample of participants aged 4 to 25. They found that the meanings became more abstract with age. Indeed, Barsalou et al. (2018) argued that the concreteness of a word is not a fixed quantity, and can vary across different uses or contexts (see also Borghi et al., 2017). Buccino et al. (2019) suggested that abstract concepts may require more complex experiences that come later in life.

Beyond Nook's analysis, the relationship between meaning-concreteness and age-of-acquisition has not been examined systematically across a broad developmental window. Many words have multiple senses or meanings. By looking at acquisition of words with multiple meanings (e.g., *state*, *grace*) and examining concreteness of each individual meaning, one could analyze change in abstractness within words and across development. For example, a seemingly concrete word such as *state* (e.g., Texas is one) also has more abstract meanings (e.g., to say more clearly). The main barrier to such an analysis has been that meaning-specific concreteness ratings have not been available. We overcame this issue in the present study by collecting meaning-specific concreteness ratings for a set of 400 English words.

The current study

In the current study we examined the concreteness of the different word meanings ascribed to single words. In 2014, Brysbaert and colleagues collected word- (but not meaning-) specific concreteness ratings of almost 40,000 English words and these ratings have been used extensively in psycholinguistic and memory research (Brysbaert et al., 2014). Concreteness is determined by ratings collected by participants where they are asked the extent to which a word refers to an entity they can clearly perceive and varies on a scale of very abstract (1) to very concrete (5). For example, participants rate words as (1) very abstract (e.g., *hope*), (2) somewhat abstract (e.g., *hunch*), (4) somewhat concrete (e.g., *rise*), and (5) very concrete (e.g., *tree*).

To measure vocabulary acquisition, we used a large set of test-based age-of-acquisition norms originally collected by Dale and O'Rourke (1981) and updated by Brysbaert and Biemiller (2017). This dataset provides test-based age-of-acquisition data for specific word meanings for children in the early school years (beginning in grade 2, approximately 7 – 8 years old) to college ages (ending in third-year college, approximately 20 – 21 years old), at 2-year intervals. A word meaning was considered acquired if half or more of the tested children accurately selected the correct meaning on a multiple-choice test. For example, the dataset shows that *bank – where money is kept* is acquired by grade 2 and *bank – turn by tilting* is acquired by college.

The goal of the present research was to examine how the abstractness of specific word meanings changes across development, to test the proposal that initially, word meanings tend to be based in sensory experience but become more abstract with age. It was hypothesized that earlier acquired meanings will be rated as more concrete while later acquired meanings will be rated as more abstract. Further, it was expected that this should be particularly pronounced for words typically categorized as concrete, and less pronounced for words typically categorized as abstract.

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

To do so, we collected concreteness ratings for specific word meanings. Using the list from Brysbaert and Biemiller (2017) and extracting words with four to eight meanings, we collected concreteness ratings for each word meaning through online surveys of adult participants. Then using the age-of-acquisition norms from Brysbaert and Biemiller, we examined the relationship between the collected meaning-specific concreteness ratings and meaning-specific age-of-acquisition norms. We also examined whether word type – that is, whether it is considered to be a concrete or abstract word according to Brysbaert et al. (2014), interacted with age-of-acquisition to predict meaning-specific concreteness.

Method

Participants

A total of 288 undergraduate students taking a psychology course at the University of Calgary took part in this study (36 men, 226 women, 5 non-binary, 1 gender-fluid, 2 other gender, 18 prefer not to answer; *Mean age* = 19.86, *SD* = 2.83). Following data cleaning (described in the results), 180 participants were included in the analysis (18 men, 145 women, 4 non-binary, 2 other gender, 11 prefer not to answer; *Mean age* = 19.89, *SD* = 2.83). All participants were recruited through the Research Participation System and received class credit for participating.

Stimuli

We began with a set of words for which there are known concreteness ratings (not meaning-specific) from Brysbaert et al. (2014), test-based age-of-acquisition for specific meanings of words from Brysbaert and Biemiller (2017), and word frequency and length values from Balota et al. (2007). From this set, the following words were removed: multi-word expressions rather than single words, as well as words with punctuation or capitalization. We then selected a final list of 400 single words with 4-8 meanings. Half the words were abstract in Brysbaert et al. (2014), with ratings less than 3 (M = 2.35, min = 1.2, max = 2.97), and half were concrete with ratings equal to or greater than 3 (M = 4.09, min = 3, max = 4.96). The abstract and concrete words were chosen such that they were matched on length and frequency. Eight different lists were generated to populate eight surveys, each containing the same 400 words, but with different meanings presented in each list. Words with fewer than eight meanings had at least one meaning repeated across the eight lists. We also selected 20 control words that had only one meaning in the Brysbaert and Biemiller (2017) age-of-acquisition data and had concreteness ratings in Brysbaert et al. (2014). These control words were added to each survey so that we could screen for invalid survey responses. Therefore, each survey had a total of 420 words (the 400 test items and the 20 control words), in a different random order for each participant. The 20 control words were used for data cleaning but not for the analysis as these words did not have multiple meanings.

Procedure

Participants were assigned one of the eight surveys via the Research Participation System and were provided with a link to the online Qualtrics survey. The survey took

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

approximately one hour to complete and began with a consent form, followed by the rating instructions, and then a set of practice words. The rating instructions were adapted from the concreteness ratings collected by Brysbaert et al. (2014) and modified to reflect the fact that the participant would be provided with a word and a specific meaning for rating (see Appendix 1).

The 420 test and control words and meanings were then presented, followed by a set of demographic questions and a debriefing screen. Each question on the survey consisted of both a word and a meaning. Participants were asked to rate the concreteness of the word based specifically on the provided meaning using a concreteness rating scale that ranged from '1-Abstract' to '5-Concrete'. They were also given the option to select 'I don't know the word meaning'. A notification was provided when participants reached the halfway point of the survey.

Results

The data were screened for invalid responses, including inattentive participants and bot responses in all eight online questionnaires following procedures outlined in other large-scale norming studies (Pexman et al., 2019; Muraki et al., 2022). First, participants who completed less than 33% of the questionnaire were excluded (n = 8), followed by participants who provided the same rating for more than 12 words in a row (n = 45). Then, each participant's ratings for the 20 control words were compared with original ratings from Brysbaert et al. (2014). Participants were excluded if their control word ratings correlated with the original data less than 0.2 (n = 48). Lastly, the remaining participants' ratings for each word meaning were correlated with the average rating of all participants for the same meaning. Participants with correlations less than .10 were excluded (n = 7). The data from a total of 108 participants were removed during data cleaning, leaving data from 180 participants. For each survey, a minimum of 20 participants were required. For usable data, survey one had 23, survey two had 21, survey three had 22, survey four had 21, survey 5 had 23, survey 6 had 21, survey 7 had 25, survey 8 had 36. In the final analysis, two words were excluded due to mismatched word meanings and five specific meanings were excluded due to receiving ratings from less than 10 participants, leaving a total of 398 words (199 abstract and 199 concrete word types based on the Brysbaert et al. ratings) and their associated meanings (n = 1,953) in our analysis.

Meaning-specific concreteness ratings were calculated (i.e., for each specific meaning of a word). The mean concreteness rating across all word meanings was 3.12 (SD = 0.89; min = 1.27, max = 5.00). The mean number of "I don't know this word meaning" responses across all word meanings was 1.89 (SD = 3.41) The skewness of mean concreteness was 0.16, indicating a mostly symmetrical distribution, and the kurtosis 1.95, indicating a more platykurtic distribution. The distribution of all meaning-specific concreteness ratings is depicted in Figure 1. We also assessed the distribution of meaning-specific concreteness by test-based age-of-acquisition. As can be seen in Figure 2, word meanings acquired at earlier grades are negatively skewed, indicating more concrete than abstract ratings. As the grades progress, the distribution is more positively skewed, indicating acquisition of more abstract meanings. By college ages, the distribution is more bi-modal, indicating acquisition of both very abstract and moderately concrete meanings. The data file with the meaning-specific mean ratings, the standard deviation of the mean ratings, and number of participants who rated each word and meaning combination is available for download at: https://osf.io/4asm3/.

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

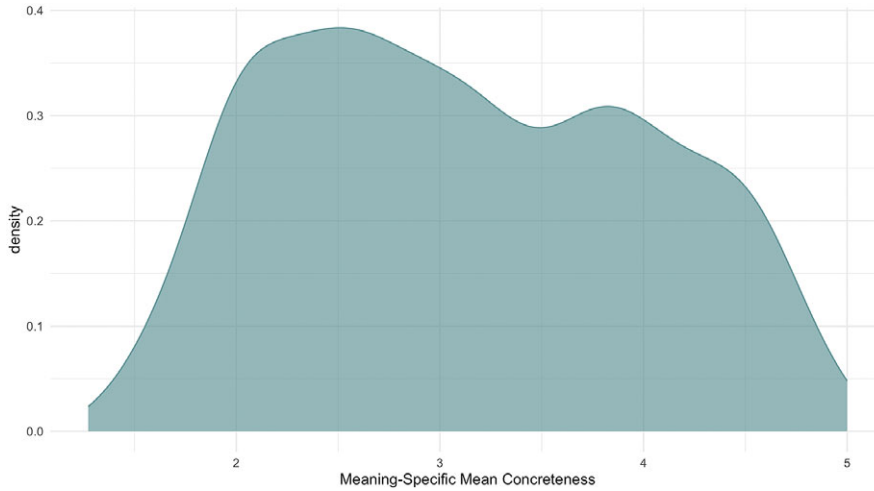

Figure 1. Mean Concreteness Ratings for Specific Word Meanings (*n* = 1,953).
Note. Distribution of concreteness ratings of 1,953 meanings associated with 398 unique words. 1 = Abstract and 5 = Concrete.

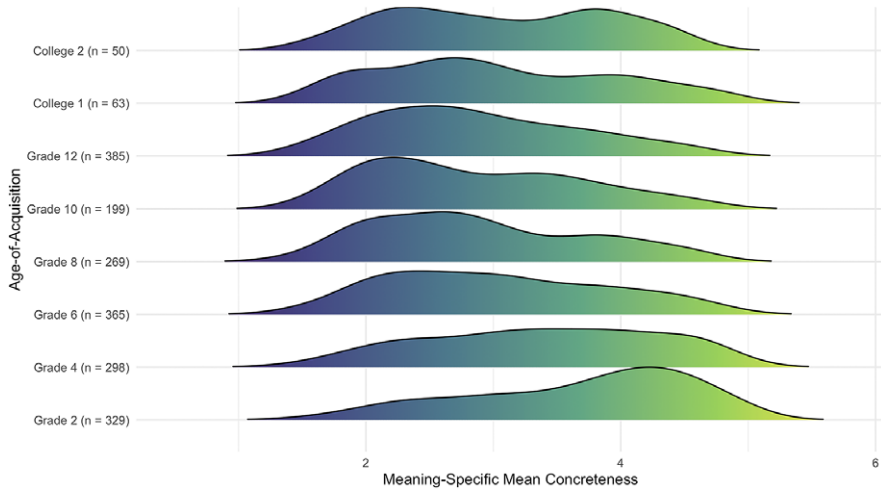

Figure 2. Mean Concreteness Ratings for Specific Word Meanings as a function of Age-of-Acquisition (*n* = 1,953)
Note. Distribution of concreteness ratings of specific meanings associated with 398 unique words. 1 = Abstract and 5 = Concrete.

We next assessed the relationship between the meaning-specific concreteness ratings and the Brysbaert et al. (2014) concreteness ratings, which did not specify a meaning. Overall, the correlation between meaning-specific concreteness ratings and the Brysbaert et al. concreteness ratings was $r = 0.59$, indicating a strong correlation but still some variance between the two ratings of the same dimension. We further examined the correlations between meaning-specific concreteness ratings and the Brysbaert et al. ratings to determine whether earlier-acquired meanings were rated more similarly to

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

the Brysbaert et al. ratings than later-acquired meanings, which would indicate that participants tend to access early acquired word meanings when asked to rate a word with no specified meaning. The correlations between meaning-specific and Brysbaert ratings were strongest in earlier grades (Grade 2 $r = 0.76$, Grade 4 $r = 0.69$, Grade 6 $r = 0.66$, Grade 8 $r = 0.57$, Grade 10 $r = 0.52$) and were moderate to weak at later grades (Grade 12 $r = 0.42$, College 1 $r = 0.28$, College 2 $r = 0.17$; see Figure 3), suggesting that concreteness ratings without specified meanings are indeed more reflective of early acquired meanings.

Finally, we examined whether age-of-acquisition accounted for variance in meaning-specific concreteness ratings, and whether this relationship differed depending on whether the word was considered abstract or concrete in the Brysbaert et al. (2014) ratings, using a longitudinal multilevel model. For any word that had multiple meanings acquired at the same age-of-acquisition we calculated the mean concreteness rating across those meanings

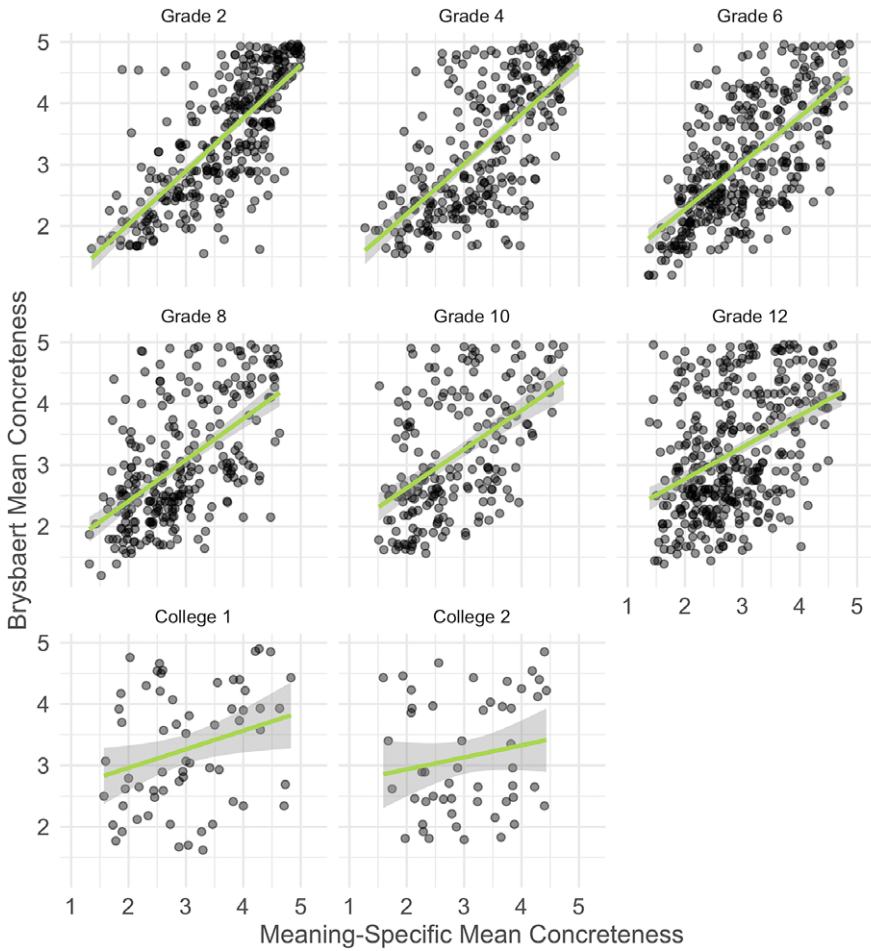

Figure 3. Relationships Between Meaning-Specific and Brysbaert Concreteness Ratings (n = 1,953)
Note. Relationships between meaning-specific concreteness ratings and concreteness ratings from Brysbaert et al. (2014) are plotted by age-of-acquisition from Brysbaert and Biemiller (2017).

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

(e.g., the word *about* had five meanings acquired in grade 2 and the mean concreteness of those meaning-specific ratings was 1.95). We then filtered the data set to include only words that had meanings acquired in at least three different grades. This left 324 words with 1,159 meaning-specific concreteness ratings in the analysis. We assessed the data for multicollinearity, linearity, homogeneity of variance, and normally distributed residuals and found no violations. Test-based age-of-acquisition was mean-centered prior to entry into the model and the contrast for word type was set to concrete (1) and abstract (0).

We selected random effects by first specifying a maximal model with a random intercept of word and a random slope for age-of-acquisition by word, and a correlation between the random intercept and slope, which did not converge. We specified the same model without the correlation and this model was significantly better than a model with only a random intercept for word (χ^2 (2) = 4.40, p = .036). We then tested the maximal model using two different covariance structures to account for the non-independence in our longitudinal predictor of test-based age-of-acquisition and found no significant difference between an unstructured covariance matrix and an auto-regressive covariance matrix ($\chi^2(1) = 2.52$, p = .113). The model reported here uses an unstructured covariance matrix.

The fixed effects accounted for 40% of the variance in meaning-specific concreteness ratings. There was a significant fixed effect of word type on meaning-specific concreteness (b = -0.07, $p < .001$) and a significant fixed effect of age-of-acquisition on meaning-specific concreteness (b = -0.86, $p < .001$). However, these effects were subsumed by a significant interaction between word type and age-of-acquisition (b = 0.08, $p < .001$). We probed the interaction using a simple slopes analysis. For both word types, as age-of-acquisition increased, meaning-specific concreteness decreased, yet words that were concrete in the Brysbaert et al. (2014) ratings showed a stronger relationship between age-of-acquisition and meaning-specific concreteness ratings (b = -0.11, $p < .001$) and abstract words showed a weaker relationship (b = -0.03, $p < .001$). The full model is presented in Table 1 and the interaction is shown in Figure 4.

Discussion

The purpose of the present paper was to examine the concreteness of specific word meanings as a function of age-of-acquisition. To do so we collected meaning-specific concreteness ratings for words with multiple meanings. The aim was to examine the proposal that early word meanings tend to be based in sensorimotor experience (consistent with findings from early child developmental research, e.g., Pereira et al., 2014; Yu & Smith, 2012), but later-acquired word meanings are more abstract. Later-acquired word meanings could be acquired based on linguistic knowledge from the word's earlier acquired meaning(s) and from the contexts in which the word is used. This would be consistent with a multi-representational account for the acquisition of word meanings (Banks et al., 2021; Dove, 2011; Howell et al., 2005; Vigliocco et al., 2009). Further, it was expected that this would be particularly pronounced for words typically categorized as concrete, and less pronounced for words typically categorized as abstract.

As hypothesized, we found that word meanings acquired at earlier grades tended to be concrete meanings and word meanings acquired at later grades tended to be abstract meanings. The variability in the concreteness ratings across word meanings suggests that word meaning is flexible and dynamic rather than static. The meaning of a word acquired at grade 2 is more likely to be perceptible in the environment (e.g., *art – a great painting or music*) but over time expands to include more abstract word meanings (e.g., by grade

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

Table 1. Longitudinal Multilevel Model Predicting Meaning-Specific Concreteness Ratings

						95% CI	
Fixed Effects	b	*SE*	*t*	*df*	*p*	*LL*	*UL*
Intercept	2.66	0.04	69.39	314.86	< .001	2.59	2.74
AoA	−0.03	0.01	−3.34	331.89	.001	−0.04	−0.01
Word Type	−0.86	0.05	16.31	312.82	< .001	0.76	0.96
AoA*Word Type	−0.08	0.01	−7.51	297.25	< .001	−0.10	−0.06
Random Effects	Variance	*SD*	Corr				
Word intercept	0.13	0.36					
Word*AoA slope	0.001	0.04					
Residual	0.33	0.57					
ICC	0.28						
Model Fit	Marginal	Conditional					
R^2	0.40	0.56					

Note. CI = confidence interval; LL = lower limit; UL = upper limit; AoA = Age-of-Acquisition. Word type is a binary variable with concrete words as the focus group (1) and abstract words as the reference group (0). The marginal R^2 includes only the variance from the fixed effects and the conditional R^2 includes variance from both the fixed and random effects. Model equation: Meaning-specific Concreteness ~ AoA*Word Type, (1 + AoA || Word). *p*-values for fixed effects were calculated using Satterthwaite's method and confidence intervals were calculated using the Wald method. *n* of observations = 1,159, *n* of words = 324.

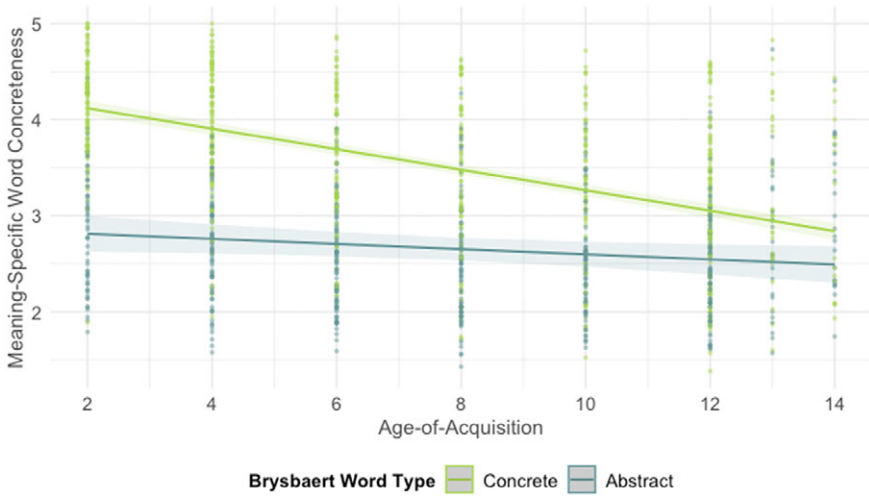

Figure 4. Interaction Between Age-of-Acquisition and Meaning-Specific Concreteness by Word Type
Note. The classification of concrete or abstract word type is based on the Brysbaert et al. (2014) ratings with concrete words having ratings >= 3 and abstract words having ratings < 3 on a 5-point scale.

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

10, *art – skill*). This suggests limitations for the traditional categorization of concrete vs abstract words as the dichotomy of concreteness may not accurately capture the context-dependent nature of word meaning.

The present results suggest that over time children add additional meanings to known labels and presumably draw on language experience to learn these word meanings when they do not have the benefit of information from sensory, motor, or emotional experience. Vocabulary growth is related to abstractness of acquired word meanings. In this way, the results are consistent with multiple representation theories in semantic development that suggest words, particularly abstract words, activate both sensorimotor and linguistic information, such as the linguistic short-cut hypothesis (Banks et al., 2021) and the learning through language proposal (Reggin et al., 2021). These results are also consistent with multiple representation theories of semantic representation such as Words as social Tools (WAT, Borghi & Binkofski, 2014; Borghi et al., 2019) and Language is an Embodied Neuroenhancement and Scaffold (LENS, Dove, 2020). See Borghi et al. (2017) and Meteyard et al. (2012) for reviews of multiple representation theories of semantic representation.

We found that for both concrete and abstract word types, as age-of-acquisition increased, meaning-specific concreteness decreased showing that as children acquired more word meanings these were increasingly abstract. A significant interaction showed, as expected, that this relationship was stronger for concrete words. The fact that children can learn abstract meanings for even very concrete words provides support for the possibility that earlier concrete meanings scaffold the learning of later abstract word meanings.

There was a strong correlation between the meaning-specific concreteness and Brysbaert et al. (2014) word-specific concreteness ratings; however, this correlation was not perfect suggesting the meaning-specific concreteness ratings added additional information. Brysbaert et al.'s ratings were more strongly correlated to meaning-specific ratings for earlier-acquired word meanings than for later-acquired word meanings, indicating that when participants are asked about the concreteness of words without instructions to rate a specific meaning, they tend to base their ratings on early-acquired word meanings. This is compatible with the results of computational studies examining primacy of early-acquired word meanings (Monaghan & Ellis, 2010).

Limitations and future directions

There are limitations to this work. First, the earliest data point in the age-of-acquisition ratings we analyzed was at grade 2, therefore there are certainly data missing regarding the concreteness of multiple meaning words in the earlier stages of vocabulary development. Second, the current project was a cross-sectional, not longitudinal, examination of word meanings across grades. This limits our inferences about vocabulary growth and mechanisms for that growth. We suggest that early concrete meanings may help scaffold later abstract meanings but further (ideally longitudinal) research is needed to examine the linguistic mechanisms that help support that learning, such as the contextual properties and associative properties (e.g., Banks et al., 2021; Muraki et al., 2022) of words and sentences. New clues about potential mechanisms have been provided by recent studies. For example, a recent study of eight infants over the second year of life found there was incremental growth of abstract words and that social interactions with caregivers were instrumental to the learning of abstract words (Bellagamba et al., 2022). In addition, Nook et al. (2020) examined the development of emotion concepts and found that there was a shift from understanding emotions within an external, concrete situation to understanding in terms of

https://doi.org/10.1017/S0305000923000569 Published online by Cambridge University Press

internalized concepts. Finally, Shablack et al. (2020) found that both situational context and informative sentence frames (e.g., linguistic information) facilitated comprehension of a novel emotion word.

Conclusion

The novel contribution of the present study is the finding that specific word meanings acquired across the early school years become increasingly abstract, and that this is particularly pronounced for words typically considered to be concrete. The new meaning-specific concreteness ratings collected in this study should provide a useful resource for other researchers interested in studying lexical semantics. Our findings support a dynamic view of word meaning and are consistent with multi-representational theories of lexical semantics, by which early word meanings are learned through sensorimotor experience and then other experiences, potentially linguistic experiences, tend to provide support for later word learning.

Acknowledgements. This work was supported by the Social Sciences and Humanities Research Council (SSHRC) of Canada Insight Grant awarded to PMP. The authors made the following contributions. EJM†: Conceptualization, Methodology, Investigation, Formal Analysis, Data Curation, Writing – Original Draft, Writing – Review & Editing, Visualization. LDR†: Conceptualization, Methodology, Investigation, Writing – Original Draft, Writing – Review & Editing. CYF: Conceptualization, Methodology, Investigation, Writing – Review & Editing. PMP: Conceptualization, Writing – Review & Editing, Supervision. †These authors contributed equally to this work.

Competing interest. The authors declare none.

References

Andrews, M., **Vigliocco, G.**, & **Vinson, D.** (2009). Integrating experiential and distributional data to learn semantic representations. *Psychological Review*, **116**(3), 463–498. https://doi.org/10.1037/a0016261

Balota, D. A., **Yap, M. J.**, **Cortese, M. J.**, **Hutchison, K. A.**, **Kessler, B.**, **Loftis, B.**, **Neely, J. H.**, **Nelson, D. L.**, **Simpson, G. B.**, & **Treiman, R.** (2007). The English Lexicon Project. *Behavior Research Methods*, **39**(3), 445–459. https://doi.org/10.3758/BF03193014

Banks, B., **Wingfield, C.**, & **Connell, L.** (2021). Linguistic distributional knowledge and sensorimotor grounding both contribute to semantic category production. *Cognitive Science*, **45**(10), e13055–n/a. https://doi.org/10.1111/cogs.13055

Barsalou, L. W. (2020). Challenges and opportunities for grounding cognition. *Journal of Cognition*, **3**(1), 31. https://doi.org/10.5334/joc.116

Barsalou, L. W., **Dutriaux, L.**, & **Scheepers, C.** (2018). Moving beyond the distinction between concrete and abstract concepts. *Philosophical Transactions of the Royal Society B: Biological Sciences* **373**(1752), 20170144. https://doi.org/10.1098/rstb.2017.0144

Bellagamba, F., **Borghi, A. M.**, **Mazzuca, C.**, **Pecora, G.**, **Ferrara, F.**, & **Fogel, A.** (2022). Abstractness emerges progressively over the second year of life. *Scientific reports*, **12**(1), 20940–20940. https://doi.org/10.1038/s41598-022-25426-5

Borghi, A. M., & **Binkofski, F.** (2014). *Words as social tools : An embodied view on abstract concepts*. Springer. https://doi.org/doi.org/10.1007/978-1-4614-9539-0

Borghi, A. M., **Barca, L.**, **Binkofski, F.**, **Castelfranchi, C.**, **Pezzulo, G.**, & **Tummolini, L.** (2019). Words as social tools: Language, sociality and inner grounding in abstract concepts. *Physics of Life Reviews*, **29**, 120–153. https://doi.org/10.1016/j.plrev.2018.12.001

Borghi, A. M., **Binkofski, F.**, **Castelfranchi, C.**, **Cimatti, F.**, **Scorolli, C.**, & **Tummolini, L.** (2017). The challenge of abstract concepts. *Psychological Bulletin*, **143**(3), 263–292. https://doi.org/10.1037/bul0000089

Brysbaert, M., & **Biemiller, A.** (2017). Test-based age-of-acquisition norms for 44 thousand English word meanings. *Behavior Research Methods*, **49**(4), 1520–1523. https://doi.org/10.3758/s13428-016-0811-4

Brysbaert, M., **Warriner, A. B.**, & **Kuperman, V.** (2014). Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research Methods*, **46**(3), 904–911. https://doi.org/10.3758/s13428-013-0403-5

Buccino, G., **Colagè, I.**, **Silipo, F.**, & **D'Ambrosio, P.** (2019). The concreteness of abstract language: An ancient issue and a new perspective. *Brain Structure and Function*, **224**(4), 1385–1401. https://doi.org/10.1007/s00429-019-01851-7

Dale, E., & **O'Rourke, J.** (1981). *The living word vocabulary, the words we know: A national vocabulary inventory*. Dome, Inc.

Dove, G. (2011). On the need for embodied and dis-embodied cognition. *Frontiers in Psychology*, **1**, 242–242. https://doi.org/10.3389/fpsyg.2010.00242

Dove, G. (2020). More than a scaffold: Language is a neuroenhancement. *Cognitive Neuropsychology*, **37**(5-6), 288–311. https://doi.org/10.1080/02643294.2019.1637338

Hills, T. T., **Maouene, J.**, **Riordan, B.**, & **Smith, L. B.** (2010). The associative structure of language: Contextual diversity in early word learning. *Journal of Memory and Language*, **63**(3), 259–273. https://doi.org/10.1016/j.jml.2010.06.002

Howell, S. R., **Jankowicz, D.**, & **Becker, S.** (2005). A model of grounded language acquisition: Sensorimotor features improve lexical and grammatical learning. *Journal of Memory and Language*, **53**(2), 258–276. https://doi.org/10.1016/j.jml.2005.03.002

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

Meteyard, L., **Cuadrado, S. R.**, **Bahrami, B.**, & **Vigliocco, G. V.** (2012). Coming of age: A review of embodiment and the neuroscience of semantics. *Cortex*, **48**(7), 788–804. https://doi.org/10.1016/j.cortex.2010.11.002

Monaghan, P., & **Ellis, A. W.** (2010). Modeling reading development: Cumulative, incremental learning in a computational model of word naming. *Journal of Memory and Language*, **63**(4), 506–525. https://doi.org/10.1016/j.jml.2010.08.003

Muraki, E. J., **Sidhu, D. M.**, & **Pexman, P. M.** (2022). Heterogenous abstract concepts: Is ponder different from dissolve? *Psychological Research*, **86**, 2478–2494. https://doi.org/10.1007/s00426-020-01398-x

Nook, E. C., **Stavish, C. M.**, **Sasse, S. F.**, **Lambert, H. K.**, **Mair, P.**, **McLaughlin, K. A.**, & **Somerville, L. H.** (2020). Charting the development of emotion comprehension and abstraction from childhood to adulthood using observer-rated and linguistic measures. *Emotion*, **20**(5), 773–792. https://doi.org/10.1037/emo0000609

Pereira, A., **Smith, L.**, & **Yu, C.** (2014). A bottom-up view of toddler word learning. *Psychonomic Bulletin & Review*, **21**(1), 178–185. https://doi.org/10.3758/s13423-013-0466-4

Pexman, P. M. (2019). The role of embodiment in conceptual development. *Language, Cognition and Neuroscience*, 1–10. https://doi.org/10.1080/23273798.2017.1303522

Pexman, P. M., **Muraki, E.**, **Sidhu, D. M.**, **Siakaluk, P. D.**, & **Yap, M. J.** (2019). Quantifying sensorimotor experience: Body–object interaction ratings for more than 9,000 English words. *Behavior Research Methods*, **51**(2), 453–466. https://doi.org/10.3758/s13428-018-1171-z

Piaget, J. (1952). *The origins of intelligence in children*. International University Press. https://doi.org/doi:10.1037/11494-000

Ponari, M., **Norbury, C.**, **Rotaru, A.**, **Lenci, A.**, & **Vigliocco, G.** (2018). Learning abstract words and concepts: Insights from developmental language disorder. *Philosophical Transactions of the Royal Society B*, **373**(1752). https://doi.org/10.1098/rstb.2017.0140

Ponari, M., **Norbury, C.**, & **Vigliocco, G.** (2018). Acquisition of abstract concepts is influenced by emotional valence. *Developmental Science*, **21**(2). 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

Reggin, L. D., **Muraki, E. J.**, & **Pexman, P. M.** (2021). Development of abstract word knowledge. *Frontiers in Psychology*, **12**, 686478–686478. https://doi.org/10.3389/fpsyg.2021.686478

Shablack, H., **Becker, M.**, & **Lindquist, K. A.** (2020). How do children learn novel emotion words? A study of emotion concept acquisition in preschoolers. *Journal of Experimental Psychology: General*, **149**(8), 1537–1553. https://doi.org/10.1037/xge0000727

Vigliocco, G., **Meteyard, L.**, **Andrews, M.**, & **Kousta, S.** (2009). Toward a theory of semantic representation. *Language and Cognition*, **1**(2), 219–247. https://doi.org/10.1515/LANGCOG.2009.011

Wauters, L. N., **Tellings, A. E. J. M.**, **Van Bon, W. H. J.**, & **Van Haaften, A. W.** (2003). Mode of acquisition of word meanings: The viability of a theoretical construct. *Applied Psycholinguistics*, **24**(3), 385–406. https://doi.org/10.1017/S0142716403000201

Yu, C., & **Smith, L. B.** (2012). Embodied attention and word learning by toddlers. *Cognition*, **125**(2), 244–262. https://doi.org/10.1016/j.cognition.2012.06.016

Appendix 1

Concreteness Rating Instructions

Some words refer to things or actions in reality, which you can experience directly through one of the five senses. We call these words concrete words. Other words refer to meanings that cannot be experienced directly but which we know because the meanings can be defined by other words. These are abstract words. Still other words fall in-between the two extremes, because we can experience them to some extent and in addition we rely on language to understand them. We want you to indicate how concrete the meaning of each word is for you by using a 5-point rating scale going from abstract to concrete.

A concrete word comes with a higher rating and refers to something that exists in reality; you can have immediate experience of it through your senses (smelling, tasting, touching, hearing, seeing) and the actions you do. The easiest way to explain a word is by pointing to it or by demonstrating it (e.g. To explain 'sweet' you could have someone eat sugar; To explain 'jump' you could simply jump up and down or show people a movie clip about someone jumping up and down; To explain 'couch', you could point to a couch or show a picture of a couch).

An abstract word comes with a lower rating and refers to something you cannot experience directly through your senses or actions. Its meaning depends on language. The easiest way to explain it is by using other words (e.g. There is no simple way to demonstrate 'justice'; but we can explain the meaning of the word by using other words that capture parts of its meaning).

Always think of how concrete (experience based) the meaning of the word is to you. In all likelihood, you will encounter several words you do not know well enough to give a useful rating. This is informative to us too, as in our research we only want to use words known to people. Please indicate when you don't know a word by selecting that answer.

A word will be presented with a meaning. You may encounter word meanings that you don't know. We only want to use word meanings known to people. We ask you to use a 5-point rating scale going from abstract to concrete to rate the concreteness of the meaning of each word and to select the "I don't know" option when you do not know the word meaning well enough to give an answer.

Please make your rating based on the meaning of the word that you are presented with. For example, a word like 'bank' could have the meaning 'turn by tilting' or 'where money is kept.' These two meanings might differ in how concrete they are. The word will be presented in bold with the meaning underneath.

Abstract (language based)			***Concrete (experience based)***		
1	*2*	*3*	*4*	*5*	*I do not know this word meaning*

Cite this article: Muraki, E.J., Reggin, L.D., Feddema, C.Y., & **Pexman, P.M.** (2023). The Development of Abstract Word Meanings. *Journal of Child Language* 1–13, https://doi.org/10.1017/S0305000923000569