Paradigm Academic Press
Journal of Innovations in Medical Research
ISSN 2788-7022
NOV. 2023 VOL.2, NO.11

Unraveling the Enigma: Exploring Varied Perspectives on Concrete-Abstract Word Contrasts

Ziyao Zuo[1]

[1] University College London, United Kingdom

Correspondence: Ziyao Zuo, University College London, United Kingdom.

doi:10.56397/JIMR/2023.11.02

Abstract

The paper delves into the complex and multifaceted nature of the concrete-abstract word contrast, examining various theoretical perspectives and empirical evidence. While the context availability theory underscores the importance of contextual knowledge, it encounters challenges in light of contradictory findings, particularly the greater right hemisphere activation for concrete words. Dual coding theory suggests that both concrete and abstract words rely on verbal information, with concrete words benefiting from additional imagistic content. However, the reverse concreteness effect, favoring abstract words, emerges when controlling for context and imageability. The affective embodiment account highlights the role of emotion in facilitating abstract words, but this too faces scrutiny as valence and abstractness prove separable. Notwithstanding inconsistencies, left hemisphere and rACC activation seem critical for encoding both word types. The paper underscores the need for future research to account for methodological variations, including factors like imageability and concreteness, participations encoding strategies and age of acquisition. It also encourages a deeper exploration of the role of emotion under controlled conditions and the identification of additional factors influencing the concrete-abstract word distinction. In sum, the paper calls for a more comprehensive understanding of the intricate interplay of variables contributing to this linguistic contrast.

Keywords: concrete-abstract word contrast, context availability theory, dual coding theory

1. Introduction

Concreteness plays a vital role in semantic memory and the differentiation between concrete and abstract words (Kousta et al., 2011; Skipper & Olson, 2014; Wang et al., 2010). The concreteness effect refers to a facilitated processing for concrete rather than abstract words (Binder et al., 2005; Jessen et al., 2000). Context availability theory and dual coding theory have been proposed to explain the concreteness effect (Paivio, 1991; Schwanenflugel & Stowe, 1989). However, the affective embodiment account refutes both theories by observing the reverse concreteness effect (facilitation for abstract than concrete words) (Kousta et al., 2011; Vigliocco et al., 2014). The following discussion will be divided into three parts, each emphasizing one explanation for the concrete-abstract contrast. Each section concludes with a list of limitations. The sequence follows context availability theory, dual coding theory, and affective embodiment account. Additionally, neuroimaging and behavioral results focus on five studies (Binder et al., 2005; Jessen et al., 2000; Kousta et al., 2011; Skipper & Olson, 2014; Vigliocco et al., 2014). Finally, the conclusion synthesizes the three theories and proposes possible future directions.

2. Evidence Associated with Context Availability Theory

Context availability theory demonstrates that the difference between concrete and abstract words is rooted in their context, with denser and stronger contextual support for concrete instead of abstract words (Binder et al., 2005; Schwanenflugel, 1991; Vigliocco et al., 2014). According to this theory, faster response to concrete words

is attributable to more automatically activated associative knowledge (Jessen et al., 2000). With the concreteness effect, in other words, response time differences vanish when providing enough verbal information for both concrete and abstract words (Jessen et al., 2000; Schwanenflugel & Stowe, 1989). Evidence from electrophysiological studies also assists the context availability model by reflecting the association between amplified N400 (greater connections with semantic memory system) and concrete words (Kanske & Kotz, 2007; West & Holcomb, 2000). Additionally, this theory predicts that the same neural substrates are activated by both concrete and abstract words, with more robust and extensive activation for concrete words providing richer contextual knowledge (Schwanenflugel & Stowe, 1989). The following paragraphs will mainly address neuroimaging and behavioral results from Binder et al. (2005) and Jessen et al. (2000), which advocate context availability theory. Finally, the section will conclude with the possible limitations of this theory.

Both studies provide evidence for context availability theory by demonstrating that context may play a role in encoding words. As shown in Figure 1a, besides the main language processing regions, Jessen et al. (2000) observed greater activation for concrete words in the left parietal and left prefrontal regions. Activation of these regions might demonstrate the denser contextual knowledge associated with concrete words, thus supporting the role of context. Interestingly, though Binder et al. (2005) explained that neuroimaging results in their study may not support context availability theory. Greater activation for abstract words in frontal regions (as shown in Figure 1b, blue area) might be consistent with this theory. Previous studies have found that the left posterior inferior frontal regions were associated with phonological processes, verbal short-term memory and lexical retrieval (Fiez et al., 1999; Paulesu et al., 1993). Greater activation in these regions might reflect that abstract word retrieval is more complex than concrete word retrieval for more demanding cognitive processing. In contrast, easier retrieval for the latter word type may be explained by richer contextual information. As discussed above, both studies aimed to contrast concrete and abstract words. However, results should be interpreted cautiously due to methodological differences between these studies.

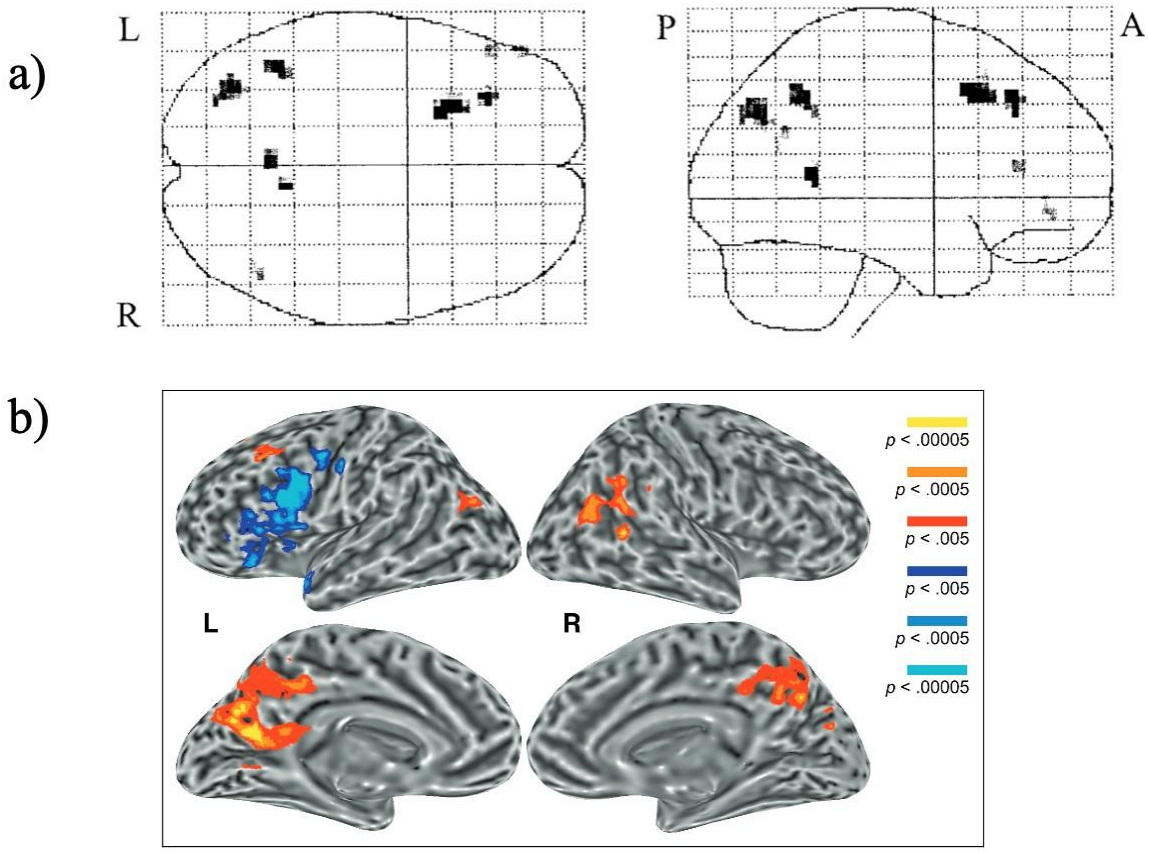

Figure 1. The activation contrast for concrete and abstract words

(a) Greater activation for concrete vs. abstract words, Adapted from Jessen et al., 2000.

(b) Blue region (abstract > concrete), Orange region (concrete > abstract), Adapted from Binder et al., 2005.

Although similar results are found in both studies, including better concrete word recognition and greater activation for abstract words in the left inferior frontal gyrus, methodological differences may have produced inconsistent results (Figure 1). First, each study featured a different task, with Jessen et al. (2000) focusing on a word memorization task, while Binder et al. (2005) applied a lexical decision task. Different task requirements may activate different brain areas, which may not be explained only by the concrete-abstract contrast. For example, Binder et al. (2005) observed greater activation for concrete words in the bilateral angular gyrus, posterior cingulate gyrus, precuneus, and the left dorsal prefrontal cortex. Jessen et al. (2000) revealed greater activation for concrete words in the left parietal area, anterior Broca's area, and the right parietal lobe and the precuneus. Differences in these results may be induced by task differences and, thus, varied encoding strategies used by participants. Second, other factors, such as control conditions and the number of participants, might also induce varied results. More controlled variables are apparent in the study of Binder et al. (2005), with matched letter length, phoneme length, mean positional bigram frequency, and orthographic neighborhood size in three conditions (50 abstract words, 50 concrete words, 100 non-words). In contrast, Jessen et al. (2000) only compared two conditions (120 abstract words and 120 concrete words) and provided no evidence for more controlled variables. A more precise comparison might come from a stricter experimental design. Additionally, a larger sample size (10 more subjects) in Binder et al. (2005) could have increased statistical power and improved precision among different condition contrasts.

In summary, context availability theory supports the higher efficiency of concrete words associated with richer contextual information. It predicts that concrete and abstract words are based on the same neural substrates (Schwanenflugel & Stowe, 1989). Although previous studies have supported this theory, sufficient contradictory neuroimaging evidence has also been found (Binder et al., 2005; Jessen et al., 2000). For instance, greater activation for concrete rather than abstract words in the right hemisphere cannot be explained by context availability theory, as both word types are supposed to activate the same brain area. Additionally, as discussed above, any interpretation of concrete-abstract contrasts should be cautiously undertaken due to methodological differences among studies. Another explanation for the difference between abstract and concrete words, dual coding theory, will be discussed in the following section.

3. Evidence Associated with Dual Coding Theory

Dual coding theory argues that concrete and abstract words are processed in two formats: concrete words use verbal and nonverbal-based codes, while abstract words use only verbal-based codes (Paivio, 1991). This theory suggests that processing concrete words benefit from additional image-based activation. In line with this theory, the brain manages abstract words in the left-lateralized hemisphere while it deals with concrete words in both the left and right hemispheres (Binder et al., 2009; Skipper & Olson, 2014). Additionally, this theory is substantiated by results from several studies (Villardita et al., 1988; Welcome et al., 2011). In a brain-lesioned study, Villardita et al. (1988) found that individuals with lesions in the right hemisphere had notably inferior performance in recalling concrete nouns. In contrast, the recollection of abstract nouns did not significantly change. In a more recent electrophysiological study, Welcome et al. (2011) demonstrated a desynchronization component for concrete words, which exists 723-938 milliseconds post-stimulus, and may be associated with mental imagery. Both studies suggest that mental imagery plays a role in encoding concrete words and thus supports dual coding theory. The following paragraphs demonstrate neuroimaging and behavioral results from Binder et al. (2005) and Jessen et al. (2000) that supporting this theory. A discussion of contradictory evidence and limitations of this theory follows.

Stronger bilateral activation for concrete words and mainly left hemisphere activation for abstract words in both studies support dual coding theory. Jessen et al. (2000) demonstrated that the robust activation in the lower right parietal lobe might indicate that the processing of concrete words involves the access of spatial imagery by a second system rather than only a verbal system. Binder et al. (2005) provided further evidence by demonstrating that activation in the precuneus, cingulate, fusiform and parahippocampal gyrus for concrete words might support the role of mental imagery in encoding concrete words. Furthermore, to better compare concrete-abstract neural representations, Wang et al. (2010) conducted a meta-analysis involving data from 303 participants and thus providing sufficient power for the comparison. As shown in Figure 2, some activated regions align with results from Binder et al. (2005). This similarity might confirm the role of mental imagery for encoding concrete words. However, as shown in Figure 1b and Figure 2, the greater activation in the right hemisphere when processing concrete rather than abstract words is not observed in the meta-analysis. Additionally, Jessen et al. (2000) found that the activation in the precuneus for abstract words, which is regarded as an image-related region, may not be explained by dual coding theory. This theory supports that the encoding of abstract words only relies on the left-lateralized verbal region.

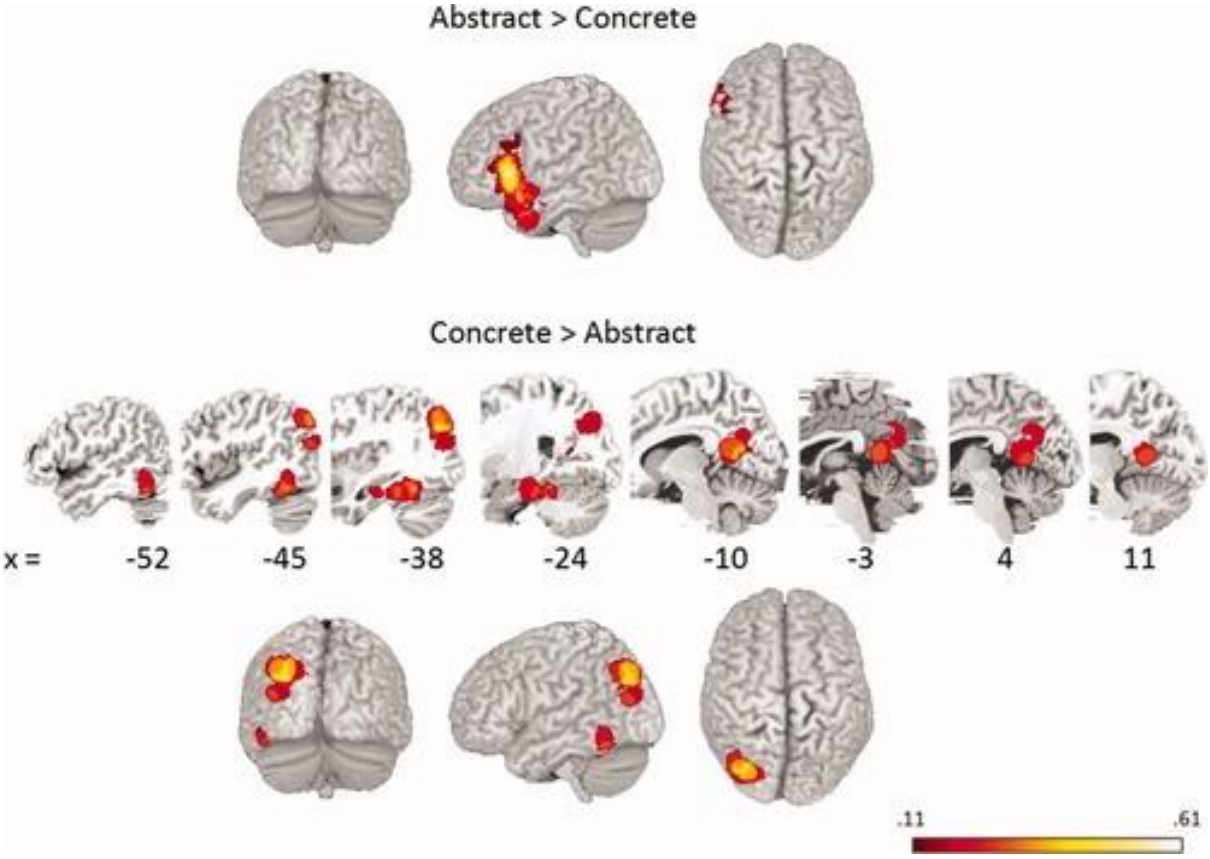

Figure 2. The abstract-concrete activation contrast in a meta-analysis, Adapted from Wang et al. 2010.

Contradictory evidence for dual coding theory comes from several studies. For example, in a behavioral study, Schwanenflugel and Stowe (1989) emphasized the importance of contextual knowledge in analyzing concreteness effects and thus supported contextual availability theory. However, as discussed in the last section, context availability may only partially explain the encoding difference between concrete and abstract words. Furthermore, in another behavioral study, Kousta et al. (2011) refuted context availability theory and dual coding theory by demonstrating that abstract word recognition was faster than concrete word recognition when matching imageability and context availability for both word types. The response time difference reached significance by participants, $p < .001$, and by items, $p < .05$. This difference is confirmed in similar accuracy results. Behavioral outcomes from these studies suggest that dual coding theory may be not enough to explain concrete-abstract contrast.

In summary, dual coding theory predicts bilateral activation for concrete words while only left-hemispheric activation for abstract words (Paivio, 1991). However, as discussed above, contradictory evidence for this theory comes from both neuroimaging and behavioral results. As stated by Kousta et al. (2011), neither context availability theory nor dual coding theory can fully explain the concrete-abstract contrast. However, it is interesting that Kousta et al. (2011) demonstrated that emotional content might play an important role in processing abstract words. Furthermore, Kousta et al. (2011) also differentiated imageability and concreteness by demonstrating that imageability ratings are intended to measure a gradual characteristic that reflects the varying links between words and sensory (mainly visual) attributes. In contrast, concreteness ratings serve to gauge the fundamental ontological contrast between concrete and abstract vocabulary (and their respective conceptual frameworks). Additional comparisons between concrete and abstract words, specifically emphasizing the role of emotion, will be discussed in the following section.

4. Evidence Associated with the Affective Embodiment Account

Both context availability theory and dual coding theory suggest that the processing of abstract words relies heavily on linguistic information (Paivio, 1991; Schwanenflugel & Stowe, 1989). Della Rosa et al. (2010) demonstrated that this linguistic reliance can be operationalized by subjective ratings on learning ways (language or experience) of certain words. Once “mode of acquisition” is controlled, the difference observed between the processing of concrete and abstract words cannot be explained by the prior two theories (Vigliocco et al., 2014). Within the context of embodiment, abstract words might be learned through metaphor (e.g., “grasp an idea”)

(Pecher, 2018), while an alternative view is that abstract words are rooted in introspective states (mental and affective) (Barsalou & Wiemer-Hastings, 2005). Based on the thesis's views, Vigliocco et al. (2009) proposed a new understanding for the difference between concrete and abstract words. The affective embodiment account demonstrated that concrete words are acquired through linguistic and sensory-motor information, while abstract words are learned through linguistic and emotional information (Vigliocco et al., 2014). This proposal suggests a specific role of emotion in processing abstract words. The following paragraph will mainly focus on results from Skipper and Olson (2014) and Vigliocco et al. (2014). Supporting neuroimaging and behavioral findings for this proposal will be discussed and followed by a discussion of the role of the rostral anterior cingulate cortex (rACC), which modulates emotion (Vigliocco et al., 2014). Finally, contradictory findings and limitations of this proposal will be analyzed.

Both studies emphasize the role of emotion in processing words. Vigliocco et al. (2014), stated that when investigators control for orthographic and semantic factors, the degree of affective associations might predict processing between concrete and abstract words. This viewed is supported by behavioral outcomes, including shorter processing time for abstract words than concrete words when investigators did not control for valence and arousal. This difference reached significance ($p < .005$). Though Skipper and Olson (2014) did not find the facilitation for abstract words, the role of emotion is also confirmed by behavioral results. For example, as shown in Figure 3a, though most behavioral findings are in contrast to those of Vigliocco et al. (2014), faster processing for valenced rather than neutral abstract words are observed. More convincing results for emotion appear in neuroimaging results, with both studies emphasizing the role of rACC.

a)

	Accuracy		RT	
	Neutral	Valenced	Neutral	Valenced
Abstract	.879 (.079)	.837 (.121)	2090.71 (256.88)	2046.29 (305.81)
Concrete	.884 (.114)	.902 (.084)	1967.70 (296.59)	2005.19 (254.34)
Nonword	.792 (.104)	–	2127.99 (330.97)	–

b)

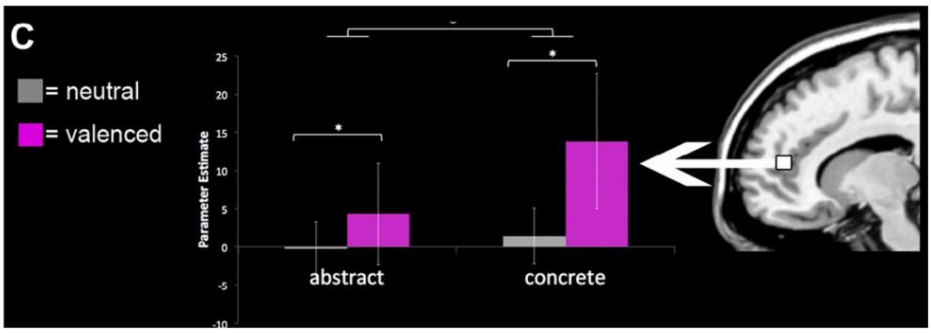

Figure 3. (a) Behavioral results. (b) Region of interest results (rACC). Adapted from Skipper & Olson, 2014.

Neuroimaging results from both studies demonstrate engagement of the rACC in processing words, however, the interpretation of activation in this region is different between the two studies. Previous studies have suggested that the rACC is linked with the evaluation of emotional valence for both external and internal stimuli and also the modulation of emotion in emotional conflict conditions (Kanske & Kotz, 2007; Phan et al., 2002). Vigliocco et al. (2014) explained that greater activation in the rACC for abstract rather than concrete words is caused by more affective associations for abstract words. In contrast, as shown in Figure 3b, Skipper and Olson (2014) controlled for affective associations for both word types, and related activation of the rACC with concreteness (abstract/concrete) and valence (neutral/valenced). Additionally, the main effects for both concreteness and valence reached significance: ($p < .05$). This result may refute the specific role of the rACC in encoding abstract words proposed by Vigliocco et al. (2014) by demonstrating that abstractness and valence are separable.

However, the results should be interpreted carefully due to the methodological differences between the two studies. First, Skipper and Olson (2014) did not control for imageability in their study, but Vigliocco et al. (2014) did. Skipper and Olson (2014) explained that strict imageability control for both word types may result in an unusual set of abstract words (highly imageable). However, as demonstrated by Kousta et al. (2011), though 72% concreteness can be explained by imageability, the difference between the two factors is still significant. These

comparisons may suggest that not controlling for imageability may be a limitation in experimental design. Second, task requirements (a semantically deep task and a lexical decision task, respectively) also vary between the two studies. As noted by Sakreida et al. (2013), different task requirements may result in varied neuroimaging results. This view may suggest that the interpretation of neuroimaging results for the concrete-abstract contrast should be careful because other factors may also influence brain activation. Third, the age of acquisition, which is considered to be an important factor in affective embodiment account, was not controlled for by Skipper and Olson (2014). This absence may also complicate the comparison of concrete-abstract contrast in the two studies.

In summary, besides context availability theory and dual coding theory, the affective embodiment account provides another explanation for the concrete-abstract word contrast by emphasizing a unique role of emotional content for abstract words. However, Skipper and Olson (2014), noted that abstractness and valence can be separated, thus somewhat against affective embodiment account. Furthermore, as noted above, results should be interpreted cautiously due to methodological differences, specifically controlling measures. However, it is interesting to note that, despite methodological differences, Binder et al. (2005) and Vigliocco et al. (2014) found concrete and abstract words share overlapping activation in the left angular gyrus, middle and inferior temporal gyri, and dorsolateral prefrontal cortex. This finding may provide further evidence for the importance of the left hemisphere in encoding both word types.

5. Conclusion

As discussed in the above three sections, no theory can fully explain the concrete abstract contrast. Context availability theory explains the contrast by emphasizing contextual knowledge, but contradictory evidence is shown by greater activation in the right hemisphere for concrete rather than abstract words. Dual coding theory indicates that both word types rely on verbal information, while concrete words associated with additional imagistic information. However, the reverse concreteness effect (faster response for abstract words) is observed when context availability and imageability are controlled. Additionally, one possible explanation could be that the affective embodiment account explains the facilitation of abstract words by the mode of acquisition (abstract: linguistic + emotional content; concrete: linguistic + sensory-motor content), specifically emphasizing the role of emotion. However, evidence contrary to this theory demonstrates that abstractness and valence are not inseparable, and the facilitation vanishes when investigators control for valence.

Though inconsistencies exist among studies, the left hemisphere and rACC activation should be noticed in encoding both word types. Additionally, future studies that aim to contrast concrete and abstract words should emphasize that methodological differences may produce varied results, specifically controlling for certain variables, such as the difference between imageability and concreteness, choosing word sets aligning with certain research aim (e.g., to study the concrete-abstract contrast by choosing word sets with similar certainty), participants encoding strategies, and age of acquisition. Additionally, to better contrast concrete and abstract words, solutions may rely on further analysis of the role of emotion in encoding both word types under consistent control variables, and finding additional factors that predict the difference between concrete and abstract words. Better comparisons may come from recognition of roles of different factors.

References

Barsalou, L. W., & Wiemer-Hastings, K., (2005). Situating Abstract Concepts. In D. Pecher & R. A. Zwaan (Eds.), *Grounding Cognition* (1st ed., pp. 129–163). Cambridge University Press. https://doi.org/10.1017/CBO9780511499968.007.

Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L., (2009). Where Is the Semantic System? A Critical Review and Meta-Analysis of 120 Functional Neuroimaging Studies. *Cerebral Cortex*, *19*(12), 2767–2796. https://doi.org/10.1093/cercor/bhp055.

Binder, J. R., Westbury, C. F., McKiernan, K. A., Possing, E. T., & Medler, D. A., (2005). Distinct Brain Systems for Processing Concrete and Abstract Concepts. *Journal of Cognitive Neuroscience*, *17*(6), 905–917. https://doi.org/10.1162/0898929054021102.

Della Rosa, P. A., Catricalà, E., Vigliocco, G., & Cappa, S. F., (2010). Beyond the abstract — concrete dichotomy: Mode of acquisition, concreteness, imageability, familiarity, age of acquisition, context availability, and abstractness norms for a set of 417 Italian words. *Behavior Research Methods*, *42*(4), 1042–1048. https://doi.org/10.3758/BRM.42.4.1042.

Fiez, J. A., Balota, D. A., Raichle, M. E., & Petersen, S. E., (1999). Effects of Lexicality, Frequency, and Spelling-to-Sound Consistency on the Functional Anatomy of Reading. *Neuron*, *24*(1), 205–218. https://doi.org/10.1016/S08966273(00)80833-8.

Jessen, F., Heun, R., Erb, M., Granath, D.-O., Klose, U., Papassotiropoulos, A., & Grodd, W., (2000). The

Concreteness Effect: Evidence for Dual Coding and Context Availability. *Brain and Language*, *74*(1), 103–112. https://doi.org/10.1006/brln.2000.2340.

Kanske, P., & Kotz, S. A. (2007). Concreteness in emotional words: ERP evidence from a hemifield study. *Brain Research*, *1148*, 138–148. https://doi.org/10.1016/j.brainres.2007.02.044.

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.

Paivio, A., (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology / Revue Canadienne de Psychologie*, *45*(3), 255–287. https://doi.org/10.1037/h0084295.

Paulesu, E., Frith, C. D., & Frackowiak, R. S. J., (1993). The neural correlates of the verbal component of working memory. *Nature*, *362*(6418), 342–345. https://doi.org/10.1038/362342a0.

Pecher, D., (2018). Curb Your Embodiment. *Topics in Cognitive Science*, *10*(3), 501–517. https://doi.org/10.1111/tops.12311.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I., (2002). Functional Neuroanatomy of Emotion: A Meta-Analysis of Emotion Activation Studies in PET and fMRI. *NeuroImage*, *16*(2), 331–348. https://doi.org/10.1006/nimg.2002.1087.

Sakreida, K., Scorolli, C., Menz, M. M., Heim, S., Borghi, A. M., & Binkofski, F., (2013). Are abstract action words embodied? An fMRI investigation at the interface between language and motor cognition. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00125.

Schwanenflugel, P. J., & Stowe, R. W., (1989). Context Availability and the Processing of Abstract and Concrete Words in Sentences. *Reading Research Quarterly*, *24*(1), 114. https://doi.org/10.2307/748013.

Schwanenflugel, P. J., (1991). Chapter 2 Contextual Constraint and Lexical Processing. In *Advances in Psychology* (Vol. 77, pp. 23–45). Elsevier. https://doi.org/10.1016/S0166-4115(08)61528-9.

Skipper, L. M., & Olson, I. R., (2014). Semantic memory: Distinct neural representations for abstractness and valence. *Brain and Language*, *130*, 1–10. https://doi.org/10.1016/j.bandl.2014.01.001.

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*, *24*(7), 1767–1777. https://doi.org/10.1093/cercor/bht025.

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.

Villardita, C., Grioli, S., & Quattropani, M. C., (1988). Concreteness/Abstractness of Stimulus-Words and Semantic Clustering in Right Brain-Damaged Patients. *Cortex*, *24*(4), 563–571. https://doi.org/10.1016/S0010-9452(88)80050-9.

Wang, J., Conder, J. A., Blitzer, D. N., & Shinkareva, S. V., (2010). Neural representation of abstract and concrete concepts: A meta-analysis of neuroimaging studies. *Human Brain Mapping*, *31*(10), 1459–1468. https://doi.org/10.1002/hbm.20950.

Welcome, S. E., Paivio, A., McRae, K., & Joanisse, M. F., (2011). An electrophysiological study of task demands on concreteness effects: Evidence for dual coding theory. *Experimental Brain Research*, *212*(3), 347–358. https://doi.org/10.1007/s00221-011-2734-8.

West, W. C., & Holcomb, P. J., (2000). Imaginal, Semantic, and Surface-Level Processing of Concrete and Abstract Words: An Electrophysiological Investigation. *Journal of Cognitive Neuroscience*, *12*(6), 1024–1037. https://doi.org/10.1162/08989290051137558.