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Abstract Concepts and Pictures of Real-World Situations Activate One Another

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Abstract

Abstract concepts typically are defined in terms of lacking physical or perceptual referents. We argue instead that they are not devoid of perceptual information because knowledge of real-world situations is an important component of learning and using many abstract concepts. Although the relationship between perceptual information and abstract concepts is less straightforward than for concrete concepts, situation-based perceptual knowledge is part of many abstract concepts. In Experiment 1, participants made lexical decisions to abstract words that were preceded by related and unrelated pictures of situations. For example, *share* was preceded by a picture of two girls sharing a cob of corn. When pictures were presented for 500 ms, latencies did not differ. However, when pictures were presented for 1,000 ms, decision latencies were significantly shorter for abstract words preceded by related versus unrelated pictures. Because the abstract concepts corresponded to the pictured situation as a whole, rather than a single concrete object or entity, the necessary relational processing takes time. In Experiment 2, on each trial, an abstract word was presented for 250 ms, immediately followed by a picture. Participants indicated whether or not the picture showed a normal situation. Decision latencies were significantly shorter for pictures preceded by related versus unrelated abstract words. Our experiments provide evidence that knowledge of events and situations is important for learning and using at least some types of abstract concepts. That is, abstract concepts are grounded in situations, but in a more complex manner than for concrete concepts. Although people's understanding of abstract concepts certainly includes knowledge gained from language describing situations and events for which those

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concepts are relevant, sensory and motor information experienced during real-life events is important as well.

Keywords: Abstract concepts; Event knowledge; Situation knowledge; Picture-word processing; Grounded cognition

1. Introduction

The informational bases underlying knowledge of abstract concepts such as *idea* or *freedom* remain a theoretical challenge. One common observation is that abstract concepts differ from concrete concepts such as *chair* or *apple*. In fact, they are often defined by this difference, as being "entities that are neither purely physical nor spatially constrained" (Barsalou & Wiemer-Hastings, 2005). Their lack of obvious physical or perceptual referents plays an important role in virtually all theories of the meaning of abstract words. It has been shown that due to abstract concepts' complexity, and also to the heterogeneity of the large class of abstract concepts, how humans learn and use abstract concepts depends on numerous types of information. Theories of abstract concepts have focused on the importance of information such as emotion (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011; Kousta, Vinson, & Vigliocco, 2009), linguistic co-occurrence (Anderson, Kiela, Clark, & Poesio, 2017; Louwerse & Connell, 2011; Louwerse & Jeuniaux, 2010; Recchia & Jones, 2012), word association (Crutch & Warrington, 2010; Paivio, 2007), social information (Borghi et al., 2017), and conceptual metaphors (Lakoff, 2014).

In this article, we investigated the hypothesis that knowledge of real-world situations is an important component of abstract concepts. That is, we argue that abstract concepts are not devoid of perceptual information because knowledge of real-world situations is an important part of learning and using many abstract concepts. Although the relationship between perceptual information and abstract concepts is not as straightforward as for concrete concepts, situation-based perceptual knowledge is part of many abstract concepts. As Pecher, Boot, and Van Dantzig (2011) noted, the idea that situations are an important aspect of abstract concepts is promising, but it has seldom been investigated. Furthermore, Borghi et al. (2017) noted that evidence for this view has come almost exclusively from feature listing experiments. In two experiments, we tested whether the processing of abstract concepts is influenced by situational information provided in the form of pictures of situations.

A substantial amount of insight into, and debate about, the human conceptual system has been provided by grounded (embodied) cognition theories (Barsalou, 2008; Borghi & Pecher, 2011). Although there are several theoretical variants of this school of thought, a common claim is that people understand concepts, to varying degrees, through modality-specific brain regions (Barsalou, 2008; Chaterjee, 2010). Accordingly, concepts are not comprised of amodal symbols but are represented, at least in part, in modality-specific brain regions that process perception and action. For example, people understand verbs like *kick* via motor regions that are activated when this action is performed physically (Hauk, Johnsrude, & Pulvermüller, 2004).

There exists substantial support for aspects of grounded cognition theories with respect to concrete nouns and verbs, although the debate is ongoing (see, e.g., the 2016 special issue of *Psychonomic Bulletin & Review*). Furthermore, the degree to which grounded approaches provide insight into abstract concepts is not clear. Although grounded theories state that all concepts, to some degree, are understood through modality-specific brain regions, it has long been assumed that abstract concepts do not have modality-specific components. However, one way in which abstract concepts might be grounded is through being represented in terms of complex relations among objects, people, places, and actions, as well as an individual's internal states (introspection, thought, bodily sensations, mentalizing, emotions; Barsalou, 2008). This information might be referred to in the aggregate as situational knowledge, which includes relations among concepts that are physical and typically co-occur in situations that are experienced first-hand, or heard about, or read about.

1.1. Situations and abstract concepts

The situational-based view of abstract concepts highlights the fact that concepts do not exist in a vacuum (Schwanenflugel, 1991). Because all concepts are part of an ongoing situation or context, it is difficult to understand them independent of one's situated experience. Although concrete concepts are relatively local in time and space, most abstract concepts are not. However, this does not exclude abstract concepts from being learned through real-world episodes. Instead, it suggests that their representation relies on complex interactions that occur over space and time. Indeed, Wiemer-Hastings and Xu (2005) conducted a feature listing task using abstract and concrete concepts. When participants were asked to list item properties (their characteristics) or contextual properties (relevant contexts), they produced a great deal of situational information for abstract concepts. That is, people listed properties related to their experiences, particularly social contexts. In a sense, participants used situations to define abstract concepts (see also Roversi, Borghi, & Tummolini, 2013).

Because abstract concepts integrate components of situations that unfold over time, their meaning is flexible and depends on context. To illustrate, consider the abstract concept *advice*. *Advice* entails an agent, a patient, and a context that includes an exchange of information. The precise meaning of *advice* depends on who is giving the advice (a friend, a therapist, a lawyer, a parent), who is receiving it, and the context in which the act occurs (a school, an office, a court, a kitchen). Although concrete objects typically have situations as backgrounds (a loaf of bread in your kitchen, a restaurant, or the supermarket), many abstract concepts are aspects of the situation itself (Barrett, 2012). The meaning of an abstract concept, then, is relatively vague when a single word is presented out of context because of its reliance on people, objects, actions, and settings to constrain its meaning (Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). In other words, although both concrete and abstract concepts individuate aspects of a situation to categorize the world around us in ways we can comprehend (Barsalou, 1999), the semantics of a given abstract concept is impoverished in isolation and can change substantially depending on context.

Recent research has begun to provide support for a situationally based view of abstract concepts by demonstrating that they do, in fact, differ when presented as part of specific contexts. Wilson-Mendenhall et al. (2011) found that when *observe* was conceptualized as part of a physical threat or social threat situation, activation profiles differed from those reported in previous research, and more important, differed depending on context. For the social threat situation, *observe* elicited more widespread activation in dorsal and ventral visual processing areas, as well as auditory regions bilaterally, whereas activation was much more constrained in the physical threat situation—with little overlap between them. Wilson-Mendenhall et al. concluded that situated conceptualization is a basis of abstract concepts. In addition, Wilson-Mendenhall, Simmons, Martin, and Barsalou (2013) showed that the distributed neural patterns corresponding to the semantic information that people retrieve when they deeply process an abstract concept are revealed only when concepts are processed relative to a situational context.

Ghio and Tettamanti (2010) performed dynamic causal modeling using imaging data from a study in which participants passively read action-related ("Now I push the button." or abstract sentences ("Now I appreciate the loyalty"). For action-related sentences, left-hemisphere language areas were more functionally coupled with regions thought to subserve action representation (LSMG, LpITG). For abstract sentences, left-hemisphere language areas were more functionally coupled with areas thought to be involved in coding contextual information and monitoring introspective states (areas in the retrosplenial cortex). These results were interpreted as top-down, modality-specific reactivation of brain areas that process the semantics of both concept types. Thus, regions that process introspective states and contextual information (situational knowledge) may participate in representing concepts like *appreciate* akin to how the motor system partially represents action verbs like *kick*.

These studies provide support for a view in which situational information plays a role in representing abstract concepts, although this idea still remains relatively unexplored. As stated by Pecher et al. (2011, p. 232), "Words for abstract concepts might activate specific, concrete situations that are instances of the concept or that provide a context for the concept." Theories that focus on the centrality of situational information lead to the prediction that abstract concepts should be activated when situational information is provided, and that abstract concepts should activate situational knowledge. However, this has not been demonstrated.

1.2. The present study

The remainder of the article begins with a norming study that was used to generate stimuli for the subsequent two experiments. In Experiment 1, we tested whether pictures depicting situations facilitate processing of abstract words. In Experiment 2, we tested whether abstract words facilitate the processing of pictures depicting situations.

To the best of our knowledge, only one prior study investigated facilitation between pictures and abstract concepts. Vanderwart (1984) examined whether pictures of single entities or objects provided as much facilitation as words using a lexical decision task. For example, a picture of a lemon was used to prime the abstract concept "sour." Both picture and word primes facilitated abstract (and concrete) concepts. However, the picture primes were images of isolated concrete entities or objects, such as "*sour*" being primed by a picture of a lemon, or "*time*" being primed by a clock. In contrast, we tested whether pictures of situations would facilitate, and/or be facilitated by, abstract concepts such as "*discipline*" and "*agreement*."

2. Norming study

The purpose was to create a set of picture–word pairs consisting of a picture depicting a situation and a related abstract word.

2.1. Method

2.1.1. Participants

Forty undergraduate students from the University of Western Ontario participated for a chance to win $100. In all experiments reported herein, all participants were fluent in English and had normal or corrected-to-normal visual acuity. Participants took part in only one of the studies described in this article. All studies were conducted in accordance with the University of Western Ontario Non-Medical Research Ethics Board Guidelines.

2.1.2. Materials

From Creative Commons, we selected 57 pictures depicting situations. We chose pictures that we believed might elicit consistent responses from participants. Two pictures are shown in Fig. 1.

Fig. 1. Pictures of situations related to "discipline" and "share."

2.1.3. Procedure

A survey was created and administered using Qualtrics. Participants were asked to provide two to five words related to each picture. They were instructed to avoid naming people and objects, but rather to provide words summarizing the situation, or the emotions, feelings, or thoughts of the people in the picture. In this way, we attempted to promote the production of abstract concepts. Appendix A presents the instructions. The task was self-paced, with all participants completing the task in <1 h.

2.2. Results

Each response was ranked according to the order in which it was provided. A weighted score for each response was calculated as follows: *Rank Sum Score* = *5a* + *4b* + *3c* + *2d* + *e*, where *a, b, c, d,* and *e* refer to the number of participants who provided that response in ranks 1, 2, 3, 4, and 5, respectively. For example, given the leftmost picture in Fig. 1, "*discipline*" had a score of 74. Twelve participants listed "*discipline*" first, two participants listed it second, and two listed it third. Morphological variants of a word were combined based on whichever form had the highest rank sum score. For example, for one picture, different participants produced "*bored*" and "*boredom,*" so these responses were combined as "*bored*" because its rank sum score was higher.

The maximum possible rank sum score was 200 (40 participants times 5 if all participants provided the same word as their first response). For the 24 words that we selected for Experiments 1 and 2, the scores varied between 42 and 158, with a mean of 88. Thus, overall, it was not the case that participants were overwhelmingly producing the words that we selected for Experiments 1 and 2 given the pictures. The chosen items were elicited relatively consistently given the pictures, but the pictures brought other concepts to mind as well, at least when participants were given time to think about it.

Concreteness scores were obtained from Brysbaert, Warriner, and Kuperman (2014), who used a 1–5 scale, with 5 being most concrete. The 24 abstract words selected for Experiments 1 and 2 had a mean concreteness score of 2.4 (*SD* = 0.4, *range* = 1.6–3.2). Imageability was taken primarily from the MRC database, except for two words for which we had collected imageability ratings as part of another project. The mean imageability rating was 443, and ratings ranged from 346 to 569.

3. Experiment 1

We investigated whether pictures corresponding to real-world situations would facilitate responses to abstract concepts. It was hypothesized that participants might be faster to respond to words denoting abstract concepts that were preceded by related situation-based pictures, compared to those preceded by unrelated pictures. Pictures were presented either for 500 or 1,000 ms. Consider the pictures in Fig. 1. The target words referred to relational concepts corresponding to the picture as a whole, rather than a single depicted concrete object, entity, or action. Therefore, it seemed highly likely that it might take time for participants to perceive the entities, objects, actions, as well as the implied cognitions and emotions, and the relations among them. Finally, although participants did produce these abstract words reasonably consistently when instructed to do so in the norming study, it certainly was possible that the pictures would not automatically activate abstract concepts.

3.1. Method

3.1.1. Participants

Eighty undergraduate students from the University of Western Ontario participated for course credit. There were 42 participants in the 500 ms picture duration condition and 38 in the 1,000 ms condition.

3.1.2. Materials

The target stimuli were 24 related picture–word pairs selected from the norming study. Two lists were constructed, with each containing 12 related and 12 unrelated picture–word pairs. Within the two item rotation groups, the related picture–word pairs were shuffled among themselves to create unrelated pairings. Thus, the abstract words acted as their own controls.

The same filler trials were used for both lists. There were 24 filler trials consisting of situation-based pictures paired with unrelated abstract words. These produced a relatedness proportion of .25 (12 related trials out of 48 trials for which the target was a word). In addition, there were 48 trials consisting of situation-based pictures paired with pronounceable non-words that were of similar length to the words used in this experiment (e.g., "*plumish*"). Thus, the experiment consisted of 96 picture-letter string pairs, 50% of which included words.

Finally, there were 16 practice trials to ensure that participants understood the task. The practice trials were composed of the same proportions of trial types as in the experimental trials.

3.1.3. Procedure

Picture-letter string pairs were presented using E-PRIME software v2.1 on a PC with a 15-inch color monitor with a refresh rate of 60 ms. Button presses were recorded using Psychological Software Tools serial-response box (Model 200A), which provided millisecond accuracy. Participants used their dominant hand for "yes" responses (the letter string is an English word) and their non-dominant hand for "no" responses (the letter string is not an English word). The order of trials was randomized for each participant.

Each trial began with a fixation cross in the center of the screen for 200 ms. Immediately thereafter, a picture appeared for 500 or 1,000 ms, centered on the screen. A letter string then appeared in 24 point Arial font in the center of the screen and remained until the participant responded. The amount of time between the onset of the letter string and the lexical decision response was recorded. Response accuracy was also recorded. The intertrial interval was 1,500 ms.

The experiment took less than 30 min. Upon completion, participants were thanked, debriefed, and given course credit.

3.1.4. Design

Lexical decision latencies (ms) were analyzed using three-way mixed analyses of variance (ANOVA) by participants (F_1) and items (F_2). Relatedness was within-participants and within-items, whereas picture duration was between-participants but within-items. List (between-participants) and item rotation group (between-items) were used as dummy variables to minimize the variance due to the error associated with rotating participants and items over the two lists (Pollatsek & Well, 1995).

3.2. Results and discussion

Decision latency analyses included only trials on which the response was correct. Decision latencies longer than three standard deviations above the grand mean were replaced with that value (1.8% of the trials). Decision latencies for unrelated and related picture–word pairs in each condition are presented in Table 1.

Across the two picture durations, lexical decision latencies were 10 ms shorter for abstract words preceded by related (M = 549 ms, SE = 10 ms) as compared to unrelated (559 ms, SE = 10 ms) pictures, F_1 (1,76) = 4.49, $p < .04$, F_2 (1,22) = 6.59, $p < .02$. The interaction between picture duration and relatedness approached significance, F_1 (1,76) = 3.13, $p < .09$, F_2 (1,22) = 4.06, $p < .06$. We conducted planned comparisons to test the influence of relatedness separately at the two picture durations. When the picture was presented for 500 ms, decision latencies were only 2 ms shorter for abstract words preceded by related as compared to unrelated pictures, both F's < 1. However, when the picture was presented for 1,000 ms, decision latencies were 19 ms shorter for abstract words preceded by related pictures, F_1 (1,76) = 6.82, $p < .02$, F_2 (1,44) = 9.91, $p < .004$.

Collapsed across related and unrelated items, decision latencies were 19 ms longer when the picture was presented for 1,000 ms (M = 563 ms, SE = 14 ms) than when it was presented for 500 ms (M = 544 ms, SE = 13 ms). This difference was significant by items, F_2 (1,22) = 15.34, $p < .002$, but not by participants, F_1 (1,76) = 1.02, $p > .3$. Error analyses were not conducted because error rates were extremely low (<1% for both picture durations).

Table 1
Mean lexical decision latencies (ms) for Experiment 1

	500		1,000	
Picture Duration (ms)	*M*	*SE*	*M*	*SE*
Latencies				
Unrelated	545	14	573	14
Related	543	13	554	14
Difference	2		19[a]	

Note. [a]Significant by participants and items.

In Experiment 1, pictures of situations facilitated lexical decisions to abstract words. The abstract words denoted concepts that depended on recognizing the concrete components of the situations and the relations among them. Furthermore, the situations often implied thoughts and emotions of depicted people. Because we anticipated that it might take some time for this combinatorial processing to occur, the pictures were presented for 500 or 1,000 ms. Facilitation of related abstract concepts was obtained only when the pictures were presented for 1-s. In real situations, of course, people are involved in them, or are watching or hearing about them, for more than 1-s. In addition, the precise abstract concepts that are most highly related to a dynamic event may change over time. However, despite the complex nature of relationships between situations/events and abstract concepts, Experiment 1 showed that even static pictures can reliably activate abstract concepts.

4. Experiment 2

We tested whether abstract words would influence the processing of pictures of situations. The same picture–word combinations were used as in Experiment 1. For each trial, participants indicated whether or not “this picture shows a normal situation.” This task encouraged participants to look at a picture as they normally would, which includes recognizing the depicted components and the relations among them. Therefore, half of the trials were “no” trials in which an abstract word was followed by a picture that included an oddity in the depicted situation (these were filler trials). We tested whether shorter decision latencies for pictures would be obtained following related as compared to unrelated abstract words. For example, reading the abstract word “victory” might activate knowledge that corresponds to a certain degree to triumphant-looking individuals. This situation-based component of people’s knowledge of abstract concepts might then facilitate their response when viewing an image depicting such a scene, as opposed to the image being preceded by an unrelated abstract word.

4.1. Method

4.1.1. Participants

Forty-two undergraduate students from the University of Western Ontario participated for course credit.

4.1.2. Materials

The target items were the same as in Experiment 1. The 24 word-picture pairs were split into two rotation groups, each of which contained 12 related and 12 unrelated pairs. Within rotation groups, the related word-picture pairs were shuffled to create the unrelated pairings. Therefore, pictures acted as their own controls. Two lists were generated from the rotation groups, each consisting of the related word-picture pairs from one rotation group and the unrelated word-picture pairs from the other.

Twenty-four unrelated abstract word-picture filler trials were included. This produced a relatedness proportion of .25 (12 related trials out of 48 trials for which the target was a normal picture). Each of the 24 word-picture fillers was comprised of a situation-based image preceded by an unrelated abstract concept. The same fillers were used in both word lists.

An additional set of 48 pairs of abstract concepts and “incongruent” or “unusual” images were used so that 50% of the trials contained normal images and 50% contained incongruent images. The incongruent images were created using Adobe Photoshop CC photo editing software. Images were edited such that each contained a relatively obvious oddity and discrepancy from regular day-to-day situations. For example, one incongruent image (Fig. 2) showed a woman pulling a violin from a fresh fruit aisle in a grocery store. In total, the experiment consisted of 96 word-picture pairs.

Sixteen practice trials were included to allow the participants to become accustomed to the task. The same proportions of trial types were used in the practice trials as in the main experiment.

4.1.3. Procedure

The apparatus was the same as in Experiment 1. For each trial, participants pressed either the button indicating that “this picture shows a normal situation” with the index finger of their dominant hand or the button indicating that “this picture shows an unusual situation” with the index finger of their non-dominant hand. Each trial began with a fixation cross in the center of the screen for 200 ms, followed by the word, which appeared for 250 ms. Immediately after the word disappeared, a picture appeared in its place until the participant responded. The amount of time between the onset of the picture and the response was recorded, as was response accuracy. The intertrial interval was 1,500 ms.

Fig. 2. Picture of an incongruent situation. This picture was paired with the abstract filler word “convocation.”

The task took less than 30 min. Upon completion, participants were thanked, debriefed, and given course credit.

4.1.4. Design

Picture decision latencies (ms) were analyzed using two-way mixed analyses of variance (ANOVA) by participants (F_1) and items (F_2). Relatedness was within-participants and within-items. List (between-participants) and item rotation group (between-items) again were used as dummy variables (Pollatsek & Well, 1995).

4.2. Results & discussion

Decision latency analyses included only the trials on which the response was correct. Prior to analyses, decision latencies longer than three standard deviations above the grand mean were replaced with that value (<1% of the trials). Four participants were excluded from the analyses for having excessively high error rates. Decision latencies and error rates for unrelated and related word-picture pairs are presented in Table 2.

Decision latencies were 82 ms shorter for pictures preceded by related as compared to unrelated abstract words, F_1 (1,36) = 6.28, $p < .02$, F_2 (1,22) = 10.74, $p < .004$. The square root of the number of errors was analyzed (Myers, 1979). Error rates were 3.3% lower for related word-picture pairs, which was significant by items F_2 (1,22) = 5.58, $p < .03$, but not by participants F_1 (1,36) = 1.44, $p > .2$.

If situations and events are an important part of learning and using abstract concepts, then words referring to those concepts should activate generalized situation knowledge that is relevant to them. Experiment 2 demonstrated that abstract words facilitated people's recognition of depicted situations that were exemplars of the types of situations that are related to them. One thing to note about the results is that the picture decision latencies were greater than 1-s, which is relatively long. This occurred presumably because participants had to recognize the components of each picture, and then decide whether the depicted components constituted a normal situation. Thus, we infer that generalized situation knowledge is activated from abstract words relatively quickly, but we cannot

Table 2
Mean picture decision latencies (ms) for Experiment 2

	M	*SE*
Latencies (ms)		
Unrelated	1247	74
Related	1165	63
Difference	82[a]	
Percent errors		
Unrelated	6.8	2.0
Related	3.5	0.9
Difference	3.3	

Note. [a]Significant by participants and items.

definitively claim that it is activated absolutely immediately, for example, as the word unfolds over time in speech.

5. General discussion

Other than in unusual conditions or in some cognitive psychology experiments, concepts and the words denoting them are learned, comprehended, and produced in context. That is, dogs, chairs, and apples are experienced as parts of events and situations. These can be real-life events such as when we pet or walk a dog, or go into the fridge to choose an apple to eat. The same can be said for linguistic experience. We encounter the words *dog* or *apple* in discourse that often describes what a dog is doing or what someone is doing with an apple. Thus, an important component of people's conceptual knowledge corresponding to *dog* and *apple* concerns the events and situations in which they occur. Context, in terms of both real-life and linguistically described events and situations, is a major force that shapes human concepts.

We argue that the same is true of abstract concepts, perhaps even to a greater degree. People learn about abstract concepts such as *risk*, *helpful*, *learn*, *accomplishment*, and *creative* to a large extent by being involved in and observing situations in which they are relevant. Therefore, these situations or episodes shape our ability to comprehend and produce abstract concepts.

In Experiment 1, pictures of situations facilitated the processing of abstract words that were related to those pictures. In Experiment 2, those words facilitated the processing of depicted situations. Our results support arguments and data that have been provided by Barsalou and Wiemer-Hastings (2005), Wilson-Mendenhall et al. (2011, 2013), and Roversi et al. (2013). That is, it appears to be the case that at least some types of abstract concepts are grounded in situations, but this is more complex than is the case for concrete concepts (which is sufficiently complex in and of itself). Thus, learning and using abstract concepts depends on a number of types of information that are relevant to events and situations. Real-world situations involve, and are understood through, relations among entities (people to a great degree), objects, locations, time, emotions, and thoughts.

Finally, it should be kept in mind that the class of abstract concepts is large and heterogeneous. Stating that one type of knowledge is *the* key to abstract concepts is almost certainly wrong. Therefore, it is important to note that we are not claiming that situational knowledge is the only factor that matters for learning and using all abstract concepts. Furthermore, the idea that events and situations are important for abstract concepts is not necessarily tied to grounded cognition in its strong forms. In addition to sensory, motor, and affective information that is experienced during real-life events, people's understanding of abstract concepts certainly includes knowledge of other types. For example, linguistic experience also is central because a great deal of our knowledge comes from hearing or reading about events and situations. Language can importantly be used to highlight specific types of information or components of situations, thus providing knowledge that is relevant to many abstract concepts.

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Appendix A
Instructions for norming study

In this experiment, you will see several pictures. Your task is to view each picture then provide 2 (minimum) – 5 (maximum) words you believe are related to the image by typing them in the space below you. Please report words in the order you deem most important.

Please do not report objects, people, or physical actions depicted in the scenario.

For example, if the picture depicts a tree, do not report "tree." Rather, we would like you to focus on words that refer to emotions one might be feeling in the scenario, or words that sum up the scenario as a whole.

Here is an example picture with good responses.

1 exhausted
2 sleepy
3 tired
4 resting
5 break

Notice how we did not include words like, “girl,” “bench,” or “bicycle.”

Appendix B
Items used in the experiments

Target	Ranked Sum Score	Concreteness	Imageability
accomplishment	56	2.50	413
agreement	54	2.22	367
anger	154	2.41	488
balance	110	2.89	429
bored	158	2.13	406
creative	72	1.93	404
danger	87	2.68	505
discipline	74	2.24	386
education	74	2.93	416
excitement	93	2.48	452
exhaustion	100	3.04	505
grief	70	2.70	480
health	55	2.28	432
helpful	61	1.76	346
joy	66	2.37	533
learn	72	2.20	361
love	127	2.07	569
relaxation	134	3.04	494
risk	62	1.63	405
share	132	2.96	471
surprise	120	3.24	451
thinking	68	1.96	384
thrill	42	2.46	483
victory	75	2.55	461