AMERICAN PSYCHOLOGICAL ASSOCIATION

Emotion

ISSN: 1528-3542

https://doi.org/10.1037/emo0001327

Conceptual Structure of Emotions

Alexandra E. Kelly[1], Yoed N. Kenett[2], John D. Medaglia[1, 3], Jamie J. Reilly[4, 5, 6], Priya Dudhat[1], and Evangelia G. Chrysikou[1]

[1] Department of Psychological and Brain Sciences, Drexel University
[2] Faculty of Data and Decision Sciences, Technion — Israel Institute of Technology
[3] Department of Neurology, University of Pennsylvania
[4] Eleanor M. Saffran Center for Cognitive Neuroscience, Temple University
[5] Department of Communication Sciences and Disorders, Temple University
[6] Department of Psychology, Temple University

Theories of semantic organization have historically prioritized investigation of concrete concepts pertaining to inanimate objects and natural kinds. As a result, accounts of the conceptual representation of emotions have almost exclusively focused on their juxtaposition with concrete concepts. The present study aims to fill this gap by deriving a large set of normative feature data for emotion concepts and assessing similarities and differences between the featural representation of emotion, nonemotion abstract, and concrete concepts. We hypothesized that differences between the experience of emotions (e.g., happiness and sadness) and the experience of other abstract concepts (e.g., equality and tyranny), specifically regarding the relative importance of interoceptive states, might drive distinctions in the dimensions along which emotion concepts are represented. We also predicted, based on constructionist views of emotion, that emotion concepts might demonstrate more variability in their representation than concrete and other abstract concepts. Participants listed features which we coded into discrete categories and contrasted the feature distributions across conceptual types. Analyses revealed statistically significant differences in the distribution of features among the category types by condition. We also examined variability in the features generated, finding that, contrary to expectation, emotion concepts were associated with less variability. Our results reflect subtle differences between the structure of emotion concepts and the structure of, not only concrete concepts, but also other abstract concepts. We interpret these findings in the context of our sample, which was restricted to native English speakers, and discuss the importance of validating these findings across speakers of different languages.

Keywords: abstract concepts, emotions, feature analysis

We assume much knowledge about emotions because they lie within our realm of everyday experience—lending us the illusion of expertise. Everyone knows what it is to feel sadness or joy, as much as everyone knows what it is to feel tired or hungry. However, there remain many unanswered questions about the cognitive processes involved in experiencing and perceiving emotions. Even less clear is their conceptual structure. How do we distinguish an instance of our experience as sadness, as opposed to joy, melancholy, or depression? Integrating current theories of abstract conceptual representation with research on emotion concepts—and the experience of emotion more generally—holds much promise for an improved understanding of the conceptual structure of emotions. Clarity about the representation of these concepts can help guide the rapidly evolving research toward understanding of affect in the cognitive sciences.

The Relative Abstractness of Emotion Concepts

The history of the study of conceptual knowledge has overwhelmingly focused on concrete concepts. However, there is an increasingly growing body of work investigating abstract concepts. A key goal of this research has involved settling on an appropriate definition of abstractness. The typical definition relies on the contrast with concrete concepts, which refer to entities existing in the physical world with both spatial and temporal bounds (Barsalou & Wiemer-Hastings, 2005). This definition-by-exclusion does not establish a perfect dichotomy and might better represent a continuum, with participant judgments indicating that even concepts with perceptible referents (e.g., scientist) may be perceived as more abstract relative to other concrete entities, and vice versa (Wiemer-Hastings & Xu, 2005). As work has progressed further in this domain, there have also been calls to blur

Alexandra E. Kelly https://orcid.org/0000-0002-7057-9674
Yoed N. Kenett https://orcid.org/0000-0003-3872-7689
Evangelia G. Chrysikou https://orcid.org/0000-0001-9529-183X

The authors have no conflicts of interest to declare. This work was not preregistered. All data have been made publicly available on the Open Science Framework and can be accessed at https://osf.io/eh5dk/?view_only=0a1ab0bcfb3a4e488cc6281862836a4a.

Evangelia G. Chrysikou is supported by grant #NSF-DRL-2100137.

Alexandra E. Kelly served as lead for data curation, formal analysis, and writing–original draft. Priya Dudhat served in a supporting role for formal analysis and writing–review and editing. Evangelia G. Chrysikou contributed equally to supervision. Alexandra E. Kelly, Yoed N. Kenett, John D. Medaglia, Jamie J. Reilly, and Evangelia G. Chrysikou contributed equally to conceptualization and methodology. Yoed N. Kenett, John D. Medaglia, Jamie J. Reilly, and Evangelia G. Chrysikou contributed equally to writing–review and editing.

Correspondence concerning this article should be addressed to Alexandra E. Kelly, or Evangelia G. Chrysikou, Department of Psychological & Brain Sciences, Drexel University, 3141 Chestnut Street, Stratton Hall Room 307, Philadelphia, PA 19104, United States. Email: ak3859@drexel.edu or lilachrysikou@drexel.edu

or remove such distinctions (Barsalou et al., 2018)—although it, perhaps, remains useful to retain these conceptualizations in early attempts to define and shape subcategories in conceptual space, when establishing gross differences can enable more informed investigation of fine-grained distinctions later on. For emotion concepts, we might expect several dimensions to play a larger role in shaping the conceptual space than for other abstract concepts (e.g., moral or aesthetic).

Some theories of cognition have converged on the perspective that symbolic meaning is grounded in our sensorimotor experience, a view overall referred to as embodiment. The strongest embodiment perspectives hold that some degree of sensorimotor activation and/or simulation is integral for conceptual understanding and that various sensory modalities, depending on the nature of the task, should interact with semantic processing (see also Meteyard et al., 2012). Work specifically investigating emotion concepts has unveiled evidence for their embodiment, particularly related to the involvement of the motor system. This has been demonstrated through interference and facilitation effects when participants were asked to maintain facial expressions that were congruent or incongruent with specific emotional stimuli (Havas et al., 2007). Evidence from electromyography has also demonstrated the role of facial expression in emotion perception (Niedenthal et al., 2009). Further, functional magnetic resonance imaging has been used to show that emotion words are grounded to their referents (i.e., the emotional states they represent) via actions, specifically of facial muscles, hands, and arms (Moseley et al., 2012).

Several theories specify how this grounding of abstract concepts may arise. Barsalou's (1999) seminal perceptual symbol systems theory and situated simulation framework (Barsalou, 2009) posit that conceptual knowledge is acquired in a multimodal manner via experience with the world. According to this view, conceptual processing occurs by drawing on this stored knowledge during simulation, a process of reactivating sensory representations from knowledge acquisition. Crucially, this process is inherently situated—that is, it draws on aspects of experience that include elements in the world (Barsalou, 2009). This theory was extended specifically to abstract concepts and the elements relevant to situating them—namely, event and introspective properties of relevant contexts (Barsalou & Wiemer-Hastings, 2005). The role of social features and the social and communicative function of abstract words has also been proposed to play a significant role (Borghi et al., 2019).

Although typically classified as abstract, emotions potentially present a unique conceptual space, as we also, to an extent, "feel," "see," and even "hear" emotions in a way that may ultimately shape how emotion concepts are formed and organized in semantic memory. Many researchers are actively investigating how we are able to classify instances of emotion in others based on cues from facial expression, vocalization, and a variety of environmental cues (Phillips et al., 2003). Further, emotions have been rated as more imageable (Altarriba & Bauer, 2004) and higher in perceptual strength along the domain of interoception (Connell et al., 2018). This perceptual information, in combination with the increased salience of situational context and social features for emotions, may distinguish emotions from other abstract concepts in conceptual space.

Relevant Contributions From Psychological Constructivist Theories of Emotion

Any discussion of emotion-related constructs is bound to confront the idea that a vast majority of research on emotion implicitly relies on the acceptance of a set of emotion categories derived from our experience and the influence of the verbal labels we use to characterize them (Niedenthal, 2008; Russell, 2009). That is, most studies assume the existence of (larger or smaller) sets of emotions, and then attempt to derive information about the kinds of changes in the autonomic or somatic nervous system that are produced, for example, by sadness or happiness or how participant performance on some task changes based on the subjects' reported adherence to accepted features of sadness or happiness. This assumption matches our intuition that each emotion should be cataloged in natural language, with each discrete emotion "captured by a familiar word" (Russell, 2009). When thinking about the mental representation of emotion concepts, the fact that these generally-accepted categories may or may not captured by a specific word becomes increasingly relevant, as the question of the degree to which these a priori emotion categories represent discrete constructs with clear distinctions between them has implications for the any investigation of conceptual knowledge about them.

Indeed, over the past several decades, the question of what constitutes a discrete emotion category has received increased attention. The natural kind or basic emotion approach, in which a set of "simple" emotion experiences (deemed, in some cases, to be universally experienced or to underpin the vast array of other emotional complexity, see Ekman, 1999), cites the existence of regular and shared features, including facial expression and physiological responses, as evidence for discrete emotion categories. However, more contemporary views of emotion have convincingly argued against this structure, instead characterizing emotions as highly variable (Barrett, 2006; Cunningham et al., 2013). Psychological constructionist theories of emotion predict heterogeneity across instances within emotion categories and assume that emotion concepts do not have conceptual cores, or necessarily essential features that are present in every instantiation of the concept (Barrett, 2013).

There are various versions of psychological constructionism; constant across them is the proposition that the construction of emotion originates in the same domain-general systems that are relevant for any aspect of cognition (e.g., perception, attention, and memory). Core affect, a reflection of the neural states that correspond to feeling, is one general system that plays an important role in several of these theories. One model that explains how heterogeneity arises within emotion categories is the Iterative Reprocessing Model (Cunningham et al., 2013). In this view, emotion categories are best seen as reflecting affective trajectories, as core affect is updated over time reflecting past, present, and future predictions in the context of incoming information. Over time, as certain trajectories and their behavioral correlates are repeatedly experienced, they are categorized as a type of emotional experience. The stable representations for these categories will differ between individuals (e.g., you and I will have different prototypical elements of the emotion category fear), but will share labels across individuals (e.g., we both have some stable representation of fear).

In addition to these domain-general processes, constructionist theories also emphasize the role of situational context in emotional experience and categorization. Emotional experiences result from affective evaluations unfolding in the context of not only external environmental elements, including settings, participants, events, and objects, but also relevant mental states, including goals and evaluations (Clore & Ortony, 2013). As a result, an instance of fear formed in a social context, such as delivering a high-pressure presentation at work, will arise very differently than an instance of fear formed in the context of an encounter with a dangerous predator

(Lebois et al., 2020). Although these types of situated conceptualizations are relevant for all concepts, they may be particularly critical for the mental representation of emotions—relative to other abstract concepts—because of their greater degree of context-dependence (Altarriba & Bauer, 2004; Havas et al., 2007).

Gaining Insight Into the Conceptual Structure of Emotions: The Present Study

A constructionist perspective, rooted in situated conceptualization, is easily aligned with an exemplar view of conceptual knowledge (Lebois et al., 2020), in which learning of exemplars, or instances of emotional experience, over time results in the development of emotion categories. From this view, property generation, which has been used to assess a range of questions relating to categorization (Hampton, 1981; Rosch & Mervis, 1975), is an appropriate method of choice to glean what a participant knows about a concept and, potentially, how it is organized. Information about conceptual organization can be inferred from the properties of the features themselves (Wiemer-Hastings & Xu, 2005), or the order in which participants list features (e.g., Santos et al., 2011).

Although a large body of work and significant normative data are available for concrete concepts (e.g., McRae et al., 2005), relatively fewer studies have examined property generation for abstract concepts. These studies provide information regarding differences between abstract and concrete concepts in terms of the number of features generated, type of features most commonly produced, and the relative role of context for the features produced. The types of features participants generate allow inferences about the type of knowledge held about that concept. Entity properties reflect perceptible and intrinsic features of the concept, while situational properties include contextual knowledge about a concept's relationships to elements in situations it occurs in, and introspective properties reflect personal experiences of the concept.

For abstract concepts, it has been repeatedly reported that participants list introspective and social properties most often; in contrast, for concrete concepts, objects and entity properties are generated more frequently. Additionally, contextually-related entities or properties of situations involving the target concept are listed more frequently for abstract than concrete concepts (Barsalou & Wiemer-Hastings, 2005; Recchia & Jones, 2012; Wiemer-Hastings & Xu, 2005; Zdrazilova et al., 2018). This is in line with predictions generated by multiple theories of abstract conceptual representation more broadly as discussed above. Such results support the idea that perceptual features are relatively less important for representations of abstract concepts, and could be interpreted as consistent with a central role for introspection and events in abstract concepts as in situated conceptualization, or with accounts prioritizing associative and relational information.

To our knowledge, only one study has used property generation explicitly as a methodological paradigm with emotions as the target concepts (Niedenthal et al., 2009). The study involved a small number of participants ($N = 18$) with only a handful of emotion concepts, and the resulting properties were only analyzed in so far as to confirm differences in valence between the emotion and nonemotion stimuli. Work using data from recall (Li et al., 2020) and free association paradigms (Dover & Moore, 2020) specific to emotional states has been used to model individual differences in emotional experience. On the other hand, the lack of more extensive work on the featural elaboration of emotion concepts leaves open questions regarding whether emotion concepts differ from abstract concepts more generally in terms of the relevant semantic domains of representation, and, if so, what types of semantic features drive the distinction. The goal of the present study is to fill this conceptual and knowledge gap by deriving a large set of normative feature data for emotion concepts.

Participants performed a property generation task in which they listed features for emotion concepts and for a matching number of concrete as well as abstract, nonemotion concepts. Based on the literature reviewed above, affective information is important for grounding abstract concepts generally, and there is evidence that emotion concepts are embodied, particularly regarding motoric information; however, aside from this increased role of the motor system, it still remains largely unclear how the mental representations of emotion concepts are distinct from other types of abstract concepts. The first aim of this project is to address this knowledge gap by determining the extent to which the conceptual organization of emotion concepts differs from or overlaps with abstract but nonemotion-related concepts. Based on prior work and theory, we predicted that, similar to abstract concepts, emotions would elicit a higher number of situation and introspective properties than taxonomic or entity properties. Additionally, we anticipated that emotions would be distinguished from other abstract concepts by eliciting a higher number of entity and introspective properties, due to the observable expressions of emotions, both external (e.g., facial expression, or posture) and internal (interoceptive experience and bodily states). As a second aim, we quantified the variability in properties generated for emotions as compared to other concept types, and particularly relative to some of the most well-investigated concrete concept categories. In line with a psychological constructionist approach to emotion, we expected that individuals' featural representations would differ more within emotion concepts than within concrete concepts, given the heterogeneity within an emotion category that is predicted by this approach. This methodology also allowed us to test whether proposed basic emotions (i.e., sadness, happiness, and so on) can be treated as serving the role of superordinates of more specific emotion concepts.

Method

Transparency and Openness

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. All study stimuli and data are available at https://osf.io/eh5dk/?view_only=0a1ab0bcfb3a4e488cc6281862836a4a. This work was not preregistered.

Participants

The only exclusionary criterion for this study was status as a nonnative English speaker, which we defined as having a language other than English spoken in the home before the age of six. We did not restrict participant ages, gender identity, or racial or ethnic identity.

Two hundred and thirty-four ($N = 234$) undergraduate students were recruited from the Sona subject pool at Drexel University. All participants provided informed consent and received course credit for their participation. The study was approved by the Drexel University Institutional Review Board. Based on prior studies in the literature, we planned for a sample size of 30 participants per concept. We collected data, removing participants who were not native English speakers, those who were unable to complete the task, and those who failed to follow task instructions, until a sample of 180 participants was reached, giving us our target sample size. Participant ages ranged from 19 to 42 ($M = 19.38$). Overall, 101 participants identified as female, 75 as male, two as gender fluid, and two as transgender.

Materials

We selected a subset of emotion concepts from a study comparing perceptual strength for emotion, abstract, and concrete concepts by Connell et al. (2018), selected for the wide range of conceptual coverage. A portion of the set was derived from prototypical (or basic) emotion terms, and associated concepts were tagged with the relevant emotion (e.g., indignation, rage, and fury were tagged with "anger"). The full set of emotion concepts ($N = 574$) was pared down to restrict representation of each emotion concept to one item that best denoted a state one can experience (e.g., the full set of emotion concepts for "astonished" included "astonished," "astonishing," "astonishingly," and "astonished," and only "astonished" was retained; $N = 173$). We then culled items for which psycholinguistic norms were not available, resulting in a final set of 119 emotion concepts.

A matching number of abstract, nonemotion-related concepts were randomly selected from the same stimuli set (Connell et al., 2018). These consisted of a range of mental state, social, spiritual, and moral concepts. An equal number of concrete concepts were randomly selected from a feature generation study by Recchia and Jones (2012), representing commonly studied categories including animals, furniture, tools, modes of transportation, and weapons. The result was a pool of 357 total concepts. Psycholinguistic properties including frequency (Brysbaert & New, 2009), concreteness (Brysbaert et al., 2014), valence, and arousal (Warriner et al., 2013) of each concept category are reported in Table 1.

Procedure

Stimuli were split into six lists containing roughly equal numbers of each concept condition. Following similar property generation studies that frame the task as a game (Recchia & Jones, 2012; Zdrazilova et al., 2018), participants were instructed to list properties in the form of "clues" to a fictitious future partner who would need to guess the word they were defining. This method has been proposed to not only increase participant engagement, but also mediate differences in ease of predication between abstract and concrete concepts that may influence rate of feature production (de Mornay Davies & Funnell, 2000; Jones, 1985). Participants were instructed to provide a minimum of five properties per concept and to avoid providing synonyms, associates, or clues relating to phonology (for full participant instructions, see Appendix A). In order to prevent participants from having to generate features for concepts with which they were unfamiliar, participants were shown all stimuli from the list they would be completing prior to starting the task, and asked to select any words whose meaning they did not know. Any selected items were then not displayed to participants during the property generation task ($N = 169$, 1.56% of total concepts presented to participants).

The task was implemented in Qualtrics survey software and participants completed the task remotely on their own device. The survey took approximately 90 min to complete.

Data collection proceeded until 30 participants (except for those excluded as described above) had completed each list.

Taxonomic Feature Coding

In order to test how the featural representation of emotion concepts differs from abstract and concrete concepts, we classified properties generated by participants according to their relationship to the target concept. This allowed us to characterize the relative importance of different feature types in the representation of our three concept conditions.

Feature Preprocessing

Raw participant responses as typed in the survey were separated in cases where the participant had provided multiple distinct features within one response (e.g., for the concept duck, the response "swims in ponds" provides information about the entity behavior as well as its location; McRae et al., 2005), resulting in 56,439 individual features. Cases where participants did not follow directions, provided information outside the scope of the task, or simply repeated the target concept were coded as "miscellaneous" ($N = 3,102$) and were not considered in further analyses. Of these miscellaneous features, 25.11% were generated for emotion concepts, 40.23% for abstract concepts, and 34.65% for concrete concepts. We performed minimal preprocessing of the features that included spell-checking and standardizing equivalent responses (e.g., "has a beak," "has beak," and "beak" were standardized to "beak").

Defining the Coding Scheme

In order to facilitate comparison of the property generation data to existing norms, we adopted a modified version of a taxonomy used in multiple prior studies (McRae et al., 2005; Wu & Barsalou, 2009). Briefly, in this taxonomy there are four superordinate categories of features. Taxonomic properties characterize a place in a hierarchy of potential relationships between the feature and the concept, including superordinate and subordinate relationships, as well as

Table 1
Psycholinguistic Variables by Concept Category

	Frequency			Concreteness			Valence			Arousal		
Conceptual category	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	*R*
Emotion	81.46	453.42	0.08–3,998.96	2.10	0.37	1.37–3.13	4.62	2.17	1.71–8.47	5.03	0.81	2.95–6.83
Abstract	59.51	524.85	0.39–5,721.18	2.03	0.37	1.37–3.11	4.70	1.90	2.05–8.05	4.63	0.89	1.67–6.80
Concrete	54.58	191.27	0.35–1,845.75	4.80	0.25	3.15–5.00	5.73	1.04	3.02–8.00	3.98	0.92	2.23–6.74

Note. Frequency values reflect frequency per million words. Concreteness values reflect normative ratings on a scale from 1 to 5, with a rating of 1 indicating *low concreteness*. Valence and arousal values reflect normative ratings on a scale from 1 to 9, with ratings of 1 indicating *low valence and low arousal*.

individual instances. Some analyses of property generation data have excluded taxonomic feature types as defined in the Wu and Barsalou coding scheme, with the rationale that these are not features of target concepts themselves (Wiemer-Hastings & Xu, 2005). On the other hand, the same authors found a significant effect of word type for number of taxonomic features generated, specifically with a greater number of coordinates and synonyms generated for abstract words than for concrete words. Others (e.g., Zdrazilova et al., 2018) found no difference in the number of taxonomic properties between abstract and concrete items. Given these past findings, it remains of interest to analyze this feature type to provide clarity in its relative importance for emotion versus abstract concepts more generally, and, thus, we included it in this analysis.

Entity properties reflect perceptible and intrinsic features of the concept, including color, shape, texture, size, smell, taste, magnitude, or quantity. This broad category also includes associated abstract entities as features that are linked intrinsically with the concept and not specifically associated via contextual co-occurrence. Of note for our hypotheses, observable physical expressions of emotion (e.g., "chest puffed out," or "wrinkled forehead"), which may correlate with the observed role of motor cortex in representing emotion concepts, were coded as entity properties given their function as "surface" properties that make emotions interpretable (Schirmer & Adolphs, 2017; Wu & Barsalou, 2009). Situational properties include contextual knowledge about a concept's relationships to elements in situations it occurs in. These include the action or manner in which a concept is used, participants in situations involving the concept or the time or location of such situations, and the function of the concept. Some studies have implemented social and communicative function as a superordinate category while coding (Recchia & Jones, 2012). We decided that—although useful for purposes of evaluating the importance of social information to emotion concepts—this designation made most sense as a subtype of function more broadly and, thus, we chose to fold it into this category. Introspective properties reflect personal experiences of the concept. This includes emotional or affective responses, mental states including cognitive operations made by the participant regarding the concept such as comparison or contingencies of the concept, or evaluations of the concept or bodily responses to the concept. A full list of the feature types coded as well as examples from the data set where available is included in Appendix B.

Features were coded by Alexandra E. Kelly to maintain consistency in application of the coding criteria. Reliability of the coding scheme was confirmed by one independent rater who coded a subset of features. Initial assessments using a subset of the data (3,500 features) revealed agreement of 64.25% (Cohen's $\kappa = .52$), which is considered moderate.

Stimuli and the full feature data set generated from this work are available in a public repository hosted on the Open Science Framework: https://osf.io/eh5dk/?view_only=0a1ab0bcfb3a4e488cc6281862836a4a.

Analysis

Property Type

The property data were analyzed using mixed effects multinomial logistic regression implemented with the mclogit package in R (Elff, 2022) to model how the type of property generated varied as a function of concept type (emotion, abstract, and concrete) and the order in which the property was generated (which could indicate relative importance of the property for the conceptual representation) as fixed effects. Although participants could generate up to 10 properties for any probe, when examining the distribution of features according to the order in which they were generated there was a steep drop off with features generated sixth through tenth accounting for only 3.71% of the total number of properties generated. As a result, we grouped all properties generated after the fifth into one level. We modeled random subject intercepts and random subject slopes for condition, our main fixed effect of interest, as well as random item intercepts.

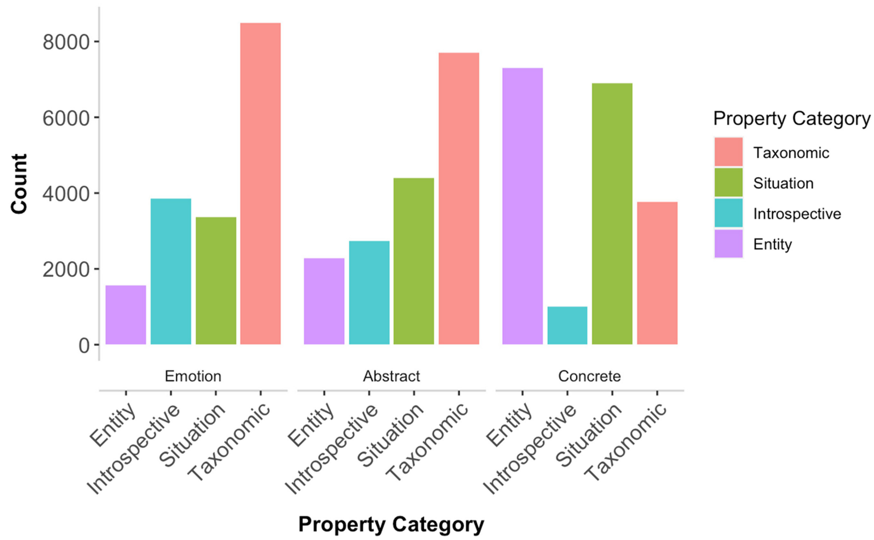
We also considered part of speech of the target concept, valence, and arousal as covariates due to variability across stimuli. We iteratively evaluated the addition of each predictor, using Likelihood ratio tests to determine whether each significantly improved model fit. Part of speech, $\chi^2(6) = 45.45$, $p < .001$, compared to model with conceptual condition and order generated, and valence, $\chi^2(3) = 47.91$, $p < .001$, compared to model with conceptual condition, order generated, and part of speech, improved model fit, but the inclusion of arousal did not, $\chi^2(3) = 5.83$, $p = .12$; note that the same random effects structure was included in each step of the model fitting process. Our final model included conceptual condition (with emotion as the reference level), order generated (with first property generated as the reference level), part of speech of conceptual stimulus (with noun as the reference level), and valence as fixed effects, random subject intercepts and slopes by condition, and random concept stimulus intercepts. Taxonomic properties, the most common type generated, were used as the reference for property type. The first property generated was used as the reference level for order generated, and noun as the reference for part of speech. The models were estimated using the mblogit function with Penalized Quasi-Likelihood method for estimating random effects.

Variability of Properties

To capture the general variability in properties produced between conceptual conditions, we computed the proportion of distinct versus shared features generated for each concept by participant and analyzed differences between conditions.

A finer-grained evaluation of the variability in features for emotion concepts was obtained by examining the subset of the stimuli that were tagged in the original set from Connell and colleagues as belonging to one of six basic emotion categories: anger ($N = 9$ concepts), disgust ($N = 7$), fear ($N = 11$), happiness ($N = 16$), love ($N = 7$), and sadness ($N = 13$). Treating each of these basic emotions as a superordinate category, we compared how many features distinguished a particular concept from other members of the same category. If a concept, such as rage, shares a majority of its features with other anger-related concepts, such as indignant, the emotion category can be said to be more homogenous; in contrast, if rage has many features that distinguish it from other concepts that could be considered subordinates of anger, the category can be said to be more heterogeneous. We computed two measures of distinctiveness of each feature for each concept—within each individual superordinate category, as well as among all of the six superordinate emotion categories. Distinctiveness reflects the degree to which features are unique to a concept versus highly shared, and it was calculated by taking the inverse of the number of concepts in which the feature appears. A distinctiveness value of 1 would indicate the feature is entirely unique to the concept, while a value close to 0 would indicate the feature is highly shared (McRae et al., 2005). In

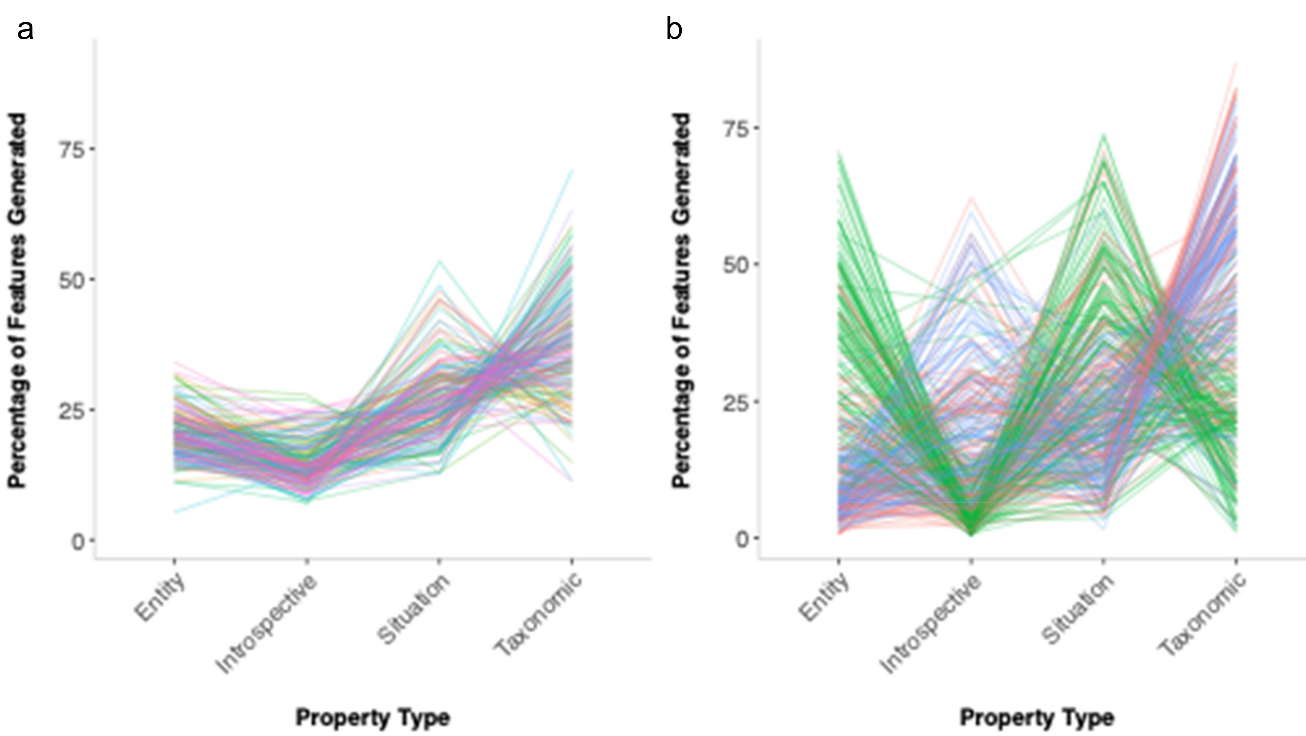
Figure 1
Property Types by Conceptual Condition



Note. See the online article for the color version of this figure.

order to better understand how the distribution of distinctiveness in emotion categories may be unique, we also computed the same set of comparisons for a subset of stimuli that belong to some of the most well-investigated concepts—the concrete categories of animals ($N = 31$), vegetables ($N = 4$), furniture ($N = 4$), tools ($N = 9$), transportation ($N = 5$), and weapons ($N = 4$).

Figure 2
Variability in Semantic Representations



Note. (a) Changes in proportion of features generated by individual participant and is colored by participant. (b) Changes in proportion of features generated for each conceptual stimulus and is colored by conceptual condition. See the online article for the color version of this figure.

Results

Distribution of Property Types

Figure 1 shows histograms reflecting the counts of each of the four major property categories for each stimulus condition for the coded subset of features ($N = 52{,}843$).

By plotting the proportion of features generated in each property category at the individual participant level (Figure 2a) and at the concept level (Figure 2b), some of the differences in participant sensitivity to particular types of semantic information and variability among concepts in featural representations that are captured by the random effects structure of our model are visible:

Table 2 reports the results of the mixed effects multinomial logistic regression analysis for fixed effects.

For effects of conceptual condition, the odds of generating an introspective feature were higher for emotion concepts relative to both abstract and concrete concepts (1.33 and 1.89 time higher, respectively). However, the odds of producing a situation property were 1.35 times higher if the concept was abstract relative to emotion, and the odds of generating an entity property were higher if the stimulus was either an abstract or a concrete as compared to an emotion concept (1.33 times and 7.04 times higher, respectively). Odds of producing an introspective feature were 1.22 times higher with an increased in valence of the conceptual stimulus. Looking at effects of the order in which properties were generated, odds were higher at all levels (i.e., all possible orders) and across all conceptual conditions of producing all three feature types relative to taxonomic after the first property listed. Figure 3 shows the count of property types by order generated across the three conceptual conditions.

Across conditions, taxonomic features were generated first most often.

Table 2
Results of Multinomial Logistic Regression Predicting Property Type

Effect	Fixed effects β	CI	Exp(β)
Entity			
Intercept	−1.77**	−0.22	0.17
Conceptual condition: abstract	0.28*	−0.14	1.33
Conceptual condition: concrete	1.95**	−0.18	7.04
Order generated: 2	0.72**	−0.04	2.05
Order generated: 3	0.99**	−0.05	2.69
Order generated: 4	1.03**	−0.05	2.79
Order generated: 5	0.97**	−0.05	2.65
Order generated: 6–10	1.04**	−0.08	2.81
Part of speech: adjective	−0.87**	−0.15	0.42
Part of speech: verb	−0.83**	−0.24	0.44
Valence	−0.03	−0.03	0.97
Introspective			
Intercept	−0.318	−0.21	0.73
Conceptual condition: abstract	−0.30*	−0.14	0.75
Conceptual condition: concrete	−0.63**	−0.18	0.53
Order generated: 2	0.55**	−0.05	1.73
Order generated: 3	0.79**	−0.05	2.20
Order generated: 4	0.86**	−0.05	2.37
Order generated: 5	0.97**	−0.05	2.64
Order generated: 6–10	0.93**	−0.09	2.52
Part of speech: adjective	−0.36	−0.15	0.70
Part of speech: verb	−1.01**	−0.24	0.36
Valence	−0.19**	−0.03	0.82
Situation			
Intercept	−1.27**	−0.22	0.28
Conceptual condition: abstract	0.28*	−0.14	1.35
Conceptual condition: concrete	1.29**	−0.18	0.53
Order generated: 2	0.69**	−0.04	1.98
Order generated: 3	0.99**	−0.04	2.69
Order generated: 4	1.10**	−0.04	3.05
Order generated: 5	1.06**	−0.04	2.90
Order generated: 6–10	1.28**	−0.08	3.60
Part of speech: adjective	−0.63**	−0.15	0.53
Part of speech: verb	−0.39	−0.25	0.36
Valence	−0.02	−0.03	0.98

* Two-tailed Wald test for coefficient significant at $p < .05$. ** Two-tailed Wald test for coefficient significant at $p < .001$.

Variability of Properties

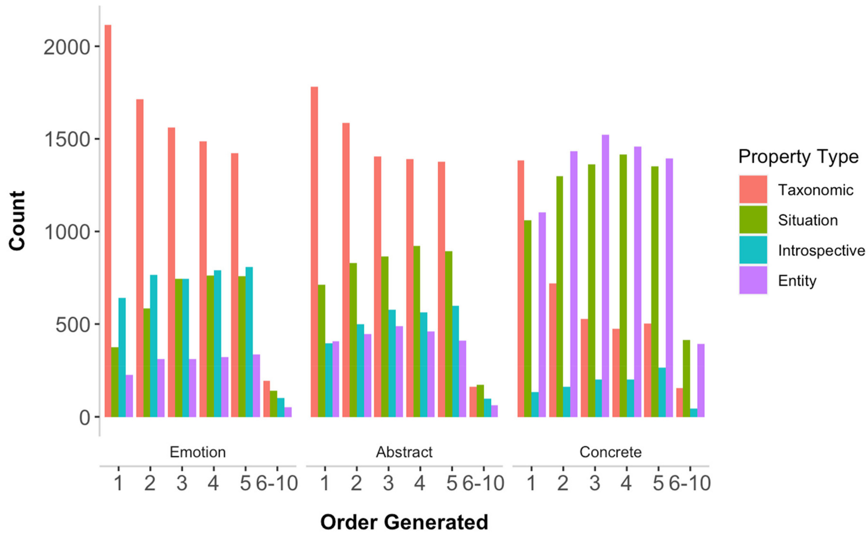
There was a small effect of conceptual condition on proportion of distinct features generated per concept, indicating that different numbers of distinct features were generated between conditions, $F(2, 38073) = 269.75$, $p < .001$, $\eta_p^2 = 0.01$. Post hoc Tukey tests showed that all three conditions differed significantly from each other, with abstract concepts having the highest proportion of distinct features per concept ($M = 0.11$), followed by concrete concepts ($M = 0.08$) and emotion concepts having the smallest proportion of distinct features ($M = 0.07$).

Figure 4 displays the distributions of distinctiveness values for all features generated for each concept within each of the analyzed categories (Panel 4a) as compared to the distribution of distinctiveness for the same features across each of the other five categories within the conceptual condition (Panel 4b). Due to the proportionally large number of taxonomic features generated for emotion concepts, we were also interested in whether the picture of distinctiveness would differ without the inclusion of taxonomic features. Figure 4a and 4b presents this analysis with taxonomic features included, while Figure 4c and 4d presents the analysis without taxonomic features.

Figure 4a and 4c can be interpreted as demonstrating how often a feature, such as "violence," distinguishes a concept such as rage from other anger concepts. Mean distinctiveness values closer to 1 indicate that most features are unique to only one concept within the superordinate category. Mean distinctiveness values for the features within the six emotion superordinate categories are relatively lower than most of the mean distinctiveness values for features within the six concrete superordinate categories, and feature distinctiveness values are more widely distributed, with more distinctiveness values closer to .50 occurring in the emotion categories. A notable exception is feature distinctiveness within the animal category. Mean feature distinctiveness for features across all animal concepts in the data set is lower than any of the other concrete categories represented, and the distribution of feature distinctiveness values looks more like that of the emotion categories. The animal category was the broadest represented in this analysis, comprising 31 distinct concepts, almost twice the number represented in the largest of the emotion categories (happiness, $N = 16$). The similarity of feature distinctiveness distributions between the relatively smaller emotion categories and this broader superordinate concrete category indicates more homogeneity within emotion categories (i.e., more features appear repeatedly among different concepts within any given emotion category) than would be expected if participants' featural representations were sensitive to individual differences. When taxonomic features were removed from consideration, the feature distinctiveness distribution for the

Figure 3

Property Types by Order Generated



Note. See the online article for the color version of this figure.

weapons category also shifted to resemble the emotion categories, and the distribution for the emotion categories of happiness and sadness also showed slight differences, indicating that different categories may be more likely to depend on taxonomic information to distinguish between concepts within category.

Figure 4b and 4d can be interpreted as reflecting how often a feature, such as "violence," distinguishes a concept such as rage from all other emotion concepts represented in this analysis. If each emotion concept had a relatively large proportion of unique features, mean feature distinctiveness would be close to 1. Instead, median and mean feature distinctiveness values for all emotion categories analyzed hover between .5 and .75, indicating that most features occurred across at least two emotion concepts in the set. The feature distinctiveness values cannot be directly compared to the values derived in the within superordinate category comparisons (Figure 4a and 4c), as different numbers of concepts are represented in each analysis; however, the distributions of feature distinctiveness for concrete and emotion categories can be directly compared, since the same number ($N = 63$) of concepts were represented in each conceptual condition. Similarities in the distributions of feature distinctiveness between all of the concepts analyzed in the concrete and emotion conceptual conditions indicates that emotion concepts appear to be no more heterogenous in their featural representations than the concrete categories represented in this data set.

Discussion

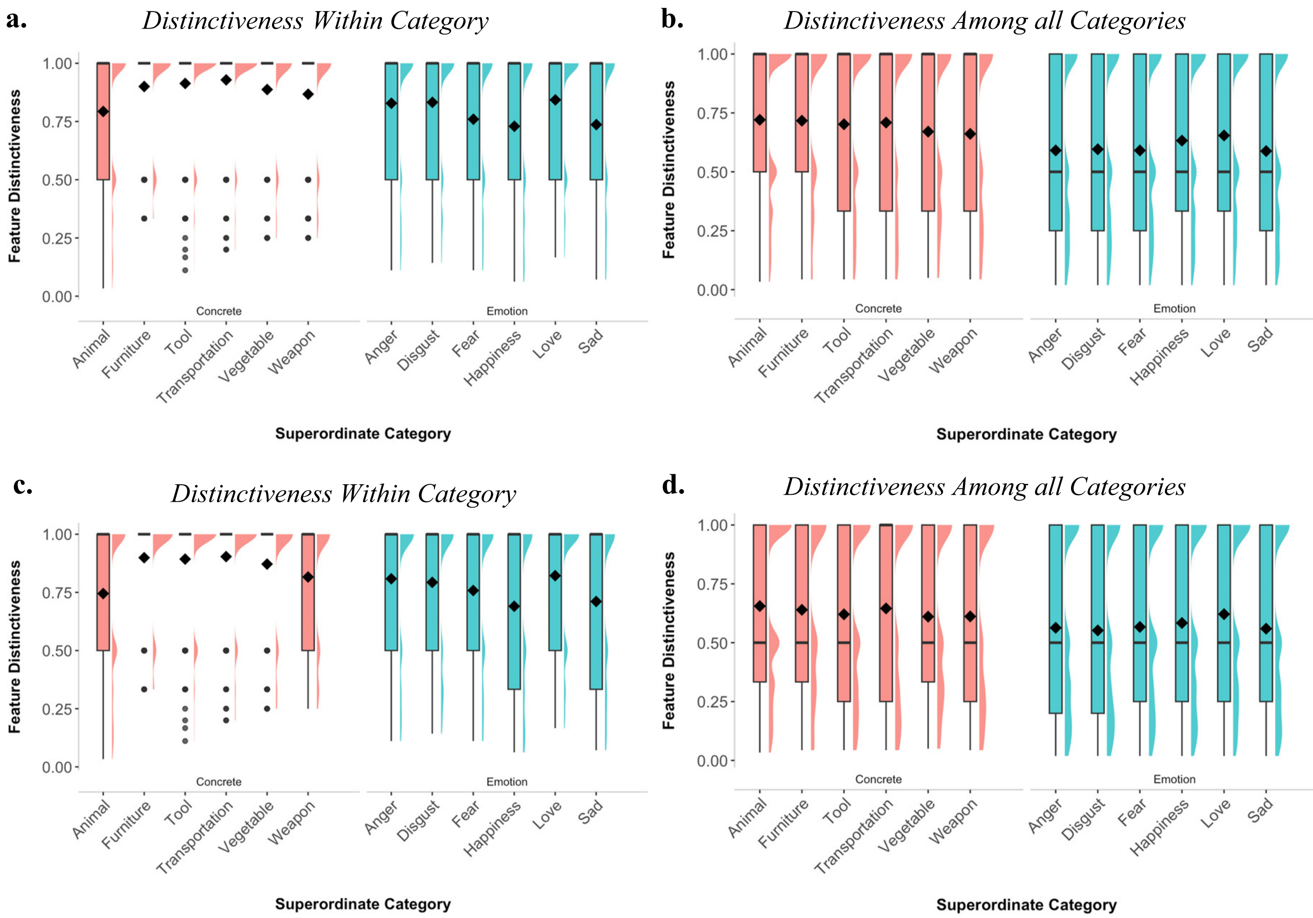
Given the prominence of affect and the presumed involvement of the motor system in theories of how emotion and abstract concepts are grounded, this project sought to characterize the featural representations of emotion concepts, especially how they are distinct from those of abstract concepts. In addition, we also examined how heterogeneity in featural representation differed between emotion and other types of concepts, as well as the distinctiveness of features generated within and between emotion categories.

Particularly notable in the feature distribution was a much higher rate of taxonomic features generated for emotion and abstract concepts as compared to concrete concepts. In the context of prior research, this unexpected finding could have significant implications for our understanding of how knowledge of emotions is acquired and represented. In all conceptual conditions participants were most likely to list a taxonomic feature first, indicating relative importance of this type of information, but as participants generated more features, a higher proportion remained taxonomic for emotion and abstract concepts. Although in this analysis superordinate and subordinate relations are included in the taxonomic property category, the vast majority of these features were coordinates and synonyms. Some previous work using abstract conceptual stimuli has reported similar rates of taxonomic feature production (Zdrazilova et al., 2018); here, the proportion of taxonomic features generated was even higher for emotion concepts than other abstract concepts. This can be interpreted as a function of a greater number of synonyms generated as features for emotion concepts (Altarriba & Bauer, 2004). The reliance on synonymous terms could be indicative of a primary role of the language system in the acquisition of knowledge of emotions. The use of synonymous terms to characterize emotions is also potentially related to individual differences in emotional granularity or one's ability to experience and identify specific emotion instances. For example, individuals with lower conceptual granularity may have distinct categorical structure for emotions that indexes fewer unique features between instances of emotions (Hoemann et al., 2020). Constructionist accounts also emphasize the role of context; it could be the case that a task with different demands that required more explicit simulation of emotional experience in varying contexts would limit participants' reliance on related emotion categories as responses, resulting in the production of fewer taxonomic features and more situation and introspective information.

Based on a regression analysis of the feature data, it appears that emotion concepts are richer in introspective features than abstract

Figure 4

Feature Distinctiveness Within and Among Semantic Categories



Note. (a) Distinctiveness within category. (b) Distinctiveness among all categories. (c) Distinctiveness within category. (d) Distinctiveness among all categories. Outliers are represented on boxplots as dots, while mean values are represented as diamonds. See the online article for the color version of this figure.

concepts. This is unsurprising given that affective information is here indexed by introspective features. Although participants did generate features related to facial, vocal, or physical expression of emotions—which was measured by entity properties—these elements were not as prominent as predicted given evidence of the motor system in representation of emotion (Moseley et al., 2012). Emotions were additionally distinguished from other abstract concepts along other dimensions. In particular, perceptual features (as indexed by entity properties) and context not involving introspection (as indexed by situation properties) appear to be more relevant for nonemotion-related abstract concepts. This finding can be interpreted as reflecting the relative importance or "focus" of situated conceptualization for abstract as compared to concrete concepts (Barsalou & Wiemer-Hastings, 2005). This is also in line with prior studies that have performed such feature analysis for abstract concepts (Barsalou & Wiemer-Hastings, 2005; Recchia & Jones, 2012; Wiemer-Hastings & Xu, 2005; Zdrazilova et al., 2018). However, these results should be interpreted with caution, as more subtle differences between emotion and abstract concepts may have been obscured here by the dominance of taxonomic information generated by the participants.

Regarding the question of whether emotion concepts demonstrate substantial variability between individuals as would be predicted by psychological construction approaches, our analysis indicated that participants produced substantially fewer unique features for emotion concepts; thus, in the context of the present study, it appears that emotion concepts may be less variable in their featural representation. Similar to the proportion of taxonomic properties generated, this could be an effect of the task we used in this investigation. However, looking at a measure of feature distinctiveness for the set of emotion concepts that share membership in one of six basic emotion categories, there were fewer distinct features produced for emotion concepts relative to a similar set of concrete concepts that were members of similarly sized discrete categories. This indicates that representations of emotion concepts might not be as heterogeneous as expected and that although there is increasing evidence that there is no physiological or neurobiological basis for claiming a set of universal, basic emotion terms (Gündem et al., 2022), at least semantically, concepts falling under the umbrella of a category such as anger or sadness may not be particularly distinct.

The present study is unique for the size of the data set generated, as well as for the range of conceptual coverage provided by the stimuli. Although the assumption is that the range of emotions included represents a homogenous construct of emotion concepts, more fine-grained differences may also be present between emotion stimuli, rooted in either differences in valence or arousal, or in other facets such as the degree to which the emotion is associated with an outward physical expression (e.g., facial expressions) as compared to internal sensation. Further analyses of this data set will produce improved inference about the nature of emotion concepts, as well as establish hypotheses for future empirical studies investigating their processing and representation.

Moving forward, another important avenue will be to examine differences between the structure of emotion concepts for speakers of different languages. Recent models have proposed that differences in the use of metonymy or embodied emotion language are related to a culture's transparency toward inner body activity, which in turn affects its language's emotional granularity (Zhou et al., 2021). Rather than pursuing a search for universal or basic emotions across cultures, productive cues can perhaps be taken from the history of the study of other cross-cultural differences in physiologically constrained phenomena such as color perception and terminology (Josserand et al., 2021). The role of both the biological pathways underlying emotion experience and the physical environment in shaping the emotion spaces of a culture should be investigated.

References

Altarriba, J., & Bauer, L. M. (2004). The distinctiveness of emotion concepts: A comparison between emotion, abstract, and concrete words. *The American Journal of Psychology*, *117*(3), 389–410. https://doi.org/10.2307/4149007

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*(1), 28–58. https://doi.org/10.1111/j.1745-6916.2006.00003.x

Barrett, L. F. (2013). Psychological construction: The Darwinian approach to the science of emotion. *Emotion Review*, *5*(4), 379–389. https://doi.org/10.1177/1754073913489753

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, *22*(4), 577–660. https://doi.org/10.1017/S0140525X99002149

Barsalou, L. W. (2009). Simulation, situated conceptualization, and prediction. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1281–1289. https://doi.org/10.1098/rstb.2008.0319

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), Article 20170144. https://doi.org/10.1098/rstb.2017.0144

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

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

Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, *41*(4), 977–990. https://doi.org/10.3758/BRM.41.4.977

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

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review*, *5*(4), 335–343. https://doi.org/10.1177/1754073913489751

Connell, L., Lynott, D., & Banks, B. (2018). Interoception: The forgotten modality in perceptual grounding of abstract and concrete concepts. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1752), Article 20170143. https://doi.org/10.1098/rstb.2017.0143

Cunningham, W. A., Dunfield, K. A., & Stillman, P. E. (2013). Emotional states from affective dynamics. *Emotion Review*, *5*(4), 344–355. https://doi.org/10.1177/1754073913489749

de Mornay Davies, P., & Funnell, E. (2000). Semantic representation and ease of predication. *Brain and Language*, *73*(1), 92–119. https://doi.org/10.1006/brln.2000.2299

Dover, Y., & Moore, Z. (2020). Using free association networks to extract characteristic patterns of affect dynamics. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *476*(2236), Article 20190647. https://doi.org/10.1098/rspa.2019.0647

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (Vol. 98, pp. 45–60). Wiley.

Elff, M. (2022). *mclogit: Multinomial logit models, with or without random effects or overdispersion* (Version 0.9.6) [Computer software]. R Package. https://CRAN.R-project.org/package=mclogit

Gündem, D., Potočnik, J., De Winter, F.-L., El Kaddouri, A., Stam, D., Peeters, R., Emsell, L., Sunaert, S., Van Oudenhove, L., Vandenbulcke, M., Feldman Barrett, L., & Van Den Stock, J. (2022). The neurobiological basis of affect is consistent with psychological construction theory and shares a common neural basis across emotional categories. *Communications Biology*, *5*(1), Article 1354. https://doi.org/10.1038/s42003-022-04324-6

Hampton, J. A. (1981). An investigation of the nature of abstract concepts. *Memory & Cognition*, *9*(2), 149–156. https://doi.org/10.3758/BF03202329

Havas, D. A., Glenberg, A. M., & Rinck, M. (2007). Emotion simulation during language comprehension. *Psychonomic Bulletin & Review*, *14*(3), 436–441. https://doi.org/10.3758/BF03194085

Hoemann, K., Fan, M., Engen, H., Chou, C.-A., Quigley, K., Gendron, M., & Barrett, L. F. (2020). *A network analytic approach to measuring emotional granularity* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/yt9cv

Jones, G. V. (1985). Deep dyslexia, imageability, and ease of predication. *Brain and Language*, *24*(1), 1–19. https://doi.org/10.1016/0093-934X(85)90094-X

Josserand, M., Meeussen, E., Majid, A., & Dediu, D. (2021). Environment and culture shape both the colour lexicon and the genetics of colour perception. *Scientific Reports*, *11*(1), Article 19095. https://doi.org/10.1038/s41598-021-98550-3

Lebois, L. A. M., Wilson-Mendenhall, C. D., Simmons, W. K., Barrett, L. F., & Barsalou, L. W. (2020). Learning situated emotions. *Neuropsychologia*, *145*, Article 106637. https://doi.org/10.1016/j.neuropsychologia.2018.01.008

Li, Y., Masitah, A., & Hills, T. T. (2020). The emotional recall task: Juxtaposing recall and recognition-based affect scales. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *46*(9), 1782–1794. https://doi.org/10.1037/xlm0000841

McRae, K., Cree, G. S., Seidenberg, M. S., & Mcnorgan, C. (2005). Semantic feature production norms for a large set of living and nonliving things. *Behavior Research Methods*, *37*(4), 547–559. https://doi.org/10.3758/BF03192726

Meteyard, L., Cuadrado, S. R., Bahrami, B., & Vigliocco, G. (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

Moseley, R., Carota, F., Hauk, O., Mohr, B., & Pulvermüller, F. (2012). A role for the motor system in binding abstract emotional meaning. *Cerebral Cortex*, *22*(7), 1634–1647. https://doi.org/10.1093/cercor/bhr238

Niedenthal, P. M. (2008). Emotion concepts. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (Vol. 3, pp. 587–600). The Guilford Press.

Niedenthal, P. M., Winkielman, P., Mondillon, L., & Vermeulen, N. (2009). Embodiment of emotion concepts. *Journal of Personality and Social Psychology*, *96*(6), 1120–1136. https://doi.org/10.1037/a0015574

Phillips, M. L., Drevets, W. C., Rauch, S. L., & Lane, R. (2003). Neurobiology of emotion perception I: The neural basis of normal emotion perception. *Biological Psychiatry*, *54*(5), 504–514. https://doi.org/10.1016/S0006-3223(03)00168-9

Recchia, G., & Jones, M. (2012). The semantic richness of abstract concepts. *Frontiers in Human Neuroscience*, *6*, Article 315. https://doi.org/10.3389/fnhum.2012.00315

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, *7*(4), 573–605. https://doi.org/10.1016/0010-0285(75)90024-9

Russell, J. A. (2009). Emotion, core affect, and psychological construction. *Cognition & Emotion*, *23*(7), 1259–1283. https://doi.org/10.1080/02699930902809375

Santos, A., Chaigneau, S. E., Simmons, W. K., & Barsalou, L. W. (2011). Property generation reflects word association and situated simulation. *Language and Cognition*, *3*(1), 83–119. https://doi.org/10.1515/langcog.2011.004

Schirmer, A., & Adolphs, R. (2017). Emotion perception from face, voice, and touch: Comparisons and convergence. *Trends in Cognitive Sciences*, *21*(3), 216–228. https://doi.org/10.1016/j.tics.2017.01.001

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

Wiemer-Hastings, K. K., & Xu, X. (2005). Content differences for abstract and concrete concepts. *Cognitive Science*, *29*(5), 719–736. https://doi.org/10.1207/s15516709cog0000_33

Wu, L., & Barsalou, L. W. (2009). Perceptual simulation in conceptual combination: Evidence from property generation. *Acta Psychologica*, *132*(2), 173–189. https://doi.org/10.1016/j.actpsy.2009.02.002

Zdrazilova, L., Sidhu, D. M., & Pexman, P. M. (2018). Communicating abstract meaning: Concepts revealed in words and gestures. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1752), Article 20170138. https://doi.org/10.1098/rstb.2017.0138

Zhou, P., Critchley, H., Garfinkel, S., & Gao, Y. (2021). The conceptualization of emotions across cultures: A model based on interoceptive neuroscience. *Neuroscience & Biobehavioral Reviews*, *125*, 314–327. https://doi.org/10.1016/j.neubiorev.2021.02.023

Appendix A

Property Generation Task Instructions

Below you will see a list of words. Your job is to define each word so that another person, who will take part in a later stage of the experiment and will only be able to see your definitions, is able to guess the word you were defining. You can think of this task as a game in which you need to help your partner understand the meaning of a word that you know but they don't by giving them clues.

Type a single clue in each of the text boxes next to the word. Clues can be single words or short phrases, but each clue should contain as few words as possible. You should describe properties of the idea the word refers to, including its physical features (such as how it looks, feels, or sounds), where or when you might encounter or experience it, where or when it is used or experienced, how it is used or experienced, or how it behaves. For example, for the two words below you might give the following clues:

DOG: Pet, Animal, Has fur, Barks, 4 legs, Friendly, Has a tail
DEJECTED: Slumped, Shoulders, Pout, After you've failed, Feel hopeless, No enthusiasm

A good response will, when all of the clues are combined, define or describe the idea the word refers to as completely as possible. Keep in mind that your partner will need to guess the exact word you defined, so try to give clues that will help them separate that word from other, similar words. Although a word might be used multiple ways, list properties of the most common usage (the one that you think of first when you read the word).

Remember that you should describe what the word means, and not the word itself–clues such as "starts with a 't'" or "is a three-letter word" will not be used. Do not use similar words, or synonyms, as clues. Also refrain from listing whatever comes to mind when you read the word (e.g., "cat" for the word dog), as these associated things do not describe the meaning of the word itself.

You can use your judgement to determine how many clues are necessary, and do not need to provide 10 for every word, but should give at least five. Do not spend too much time on any one word. We are interested in your first instincts.

(*Appendices continue*)

Appendix B

Property Coding Scheme

Property superordinate category	Property subordinate category	Description	Example: Concrete	Example: Abstract
Taxonomic	Synonym	A word with the same meaning as the concept	*Radio* → stereo	*Angry* → mad
Taxonomic	Superordinate	A category one level above the concept if laid out in a taxonomy	*Desk* → furniture	NA
Taxonomic	Coordinate	A category at the same level as the concept if laid out in a taxonomy	*Sword* → dagger	NA
Taxonomic	Subordinate	A category one level below the concept if laid out in a taxonomy	*Cheese* → Swiss	NA
Taxonomic	Individual	A specific instance of a concept	*Monument* → Eiffel Tower	*Atrocity* → September 11
Entity	Associated abstract entity	Something that cannot be physically experienced (seen, touched, etc.), but is associated with or co-occurs with the concept	*Sword* → honor	*Education* → literacy
Entity	Entity behavior	A typical action a concept performs	*Ball* → bounces	NA
Entity	External component	An external three-dimensional part of the concept	*Jacket* → sleeve	NA
Entity	External surface property	A property observable from the outside of something, including color, shape, pattern, texture, size, smell, taste, or sound	*Sword* → rusty	*Unprepared* → messy hair
Entity	Internal component	A three-dimensional part of the concept that cannot be seen from the outside	*Jacket* → down or feathers	NA
Entity	Internal surface property	A property observable through the senses on the inside of something, including color, shape, pattern, texture, size, smell, taste, or sound	*Tomato* → juicy	NA
Entity	Systemic property	An emergent property of the concept, that is, produced through the combination of all of its parts. Includes states, conditions, abilities, and traits	*Jacket* → warm	NA
Entity	Larger whole	The feature represents a larger entity that the concept is part of	*Elbow* → part of body	NA
Entity	Quantity	Number, frequency, or intensity of the concept	*Ear* → come in a pair	NA
Entity	Made-of	The feature is the material or thing the concept is made of	*Key* → metal	NA
Situation	Action or manner	How you use, demonstrate, or interact with the concept	*Key* → insert in lock and turn	*Disapproval* → booing
Situation	Associated entity	Another distinct entity that you would find in a situation where the concept occurs.	*Desk* → chair	*Commitment* → ring
Situation	Function	The purpose a concept serves	*Jacket* → keeps top warm	*Livelihood* → puts food on the table
Situation	Location	Where the concept is found or takes place	*Horse* → farm	*Education* → college
Situation	Origin	Where the concept comes from	*Itch* → bug bites	*Knowledge* → books
Situation	Participant	A person in a situation who uses the concept, or interacts with other participants in the situation	*Sword* → knight	*Adoring* → parents
Situation	Time	When a situation involving the concept occurs	*Jacket* → winter	*Surprise* → birthday
Situation	Social or communicative function	Indicate that the concept is related to a social relationship or a communicative act	*Alcohol* → friends	*Disapproval* → society
Introspective	Affect or emotion	An emotion felt toward the concept or a situation involving the concept	*Prize* → happy	*Incest* → disgusting
Introspective	Evaluation	Positive or negative reactions to the concept, or assessments of how one might feel about the concept	*Cheese* → people like this	*Indecision* → a bad thing
Introspective	Cognitive operation	Mental comparisons of the concept or one of its properties with other things	*Desk* → similar to a counter	*Dislike* → less strong than hate
Introspective	Contingency	Thinking about something the concept depends on, requires, is needed to allow to happen	*Phone* → you need a data plan	NA
Introspective	Negation	The feature highlights the absence of something	*Radio* → is not a television	*Angry* → not happy
Miscellaneous	NA	This is any information that does not fit into any of the above labels, and would be irrelevant for purposes of our analysis	*Van* → Scooby Doo *Cart* → don't put it before the horse	

Note. Examples are provided with the concept in italics, followed by the feature.

Received December 5, 2022
Revision received July 17, 2023
Accepted October 19, 2023 ■