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Shapes, Colors, and Space: The Role of Concrete Referents in Abstract Concept Processing

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Abstract

This study investigates whether concrete visual referents modulate the processing of emotionally valenced abstract concepts. Using a picture-word interference paradigm, Spanish-speaking adults evaluated the valence of abstract adjectives while ignoring concurrent visual stimuli varying in shape (Kiki vs. Bouba), color (red vs. green), and spatial position (left vs. right). Accuracy and reaction times were analyzed using mixed-effects models. Results showed that color reliably influenced performance: congruent color-valence pairings (green-positive, red-negative) increased accuracy, and green selectively reduced reaction times for positive adjectives. Shape modulated reaction times only, with faster responses to positive adjectives paired with the Bouba shape. Spatial position did not interact with adjective valence in either measure. These findings indicate that concrete referents do not contribute equally to abstract concept processing and support embodied and multimodal accounts in which perceptual features, particularly color and shape, facilitate the online evaluation of abstract emotional meaning.

Keywords: cognitive semantics; abstract concepts; semantics

Introduction

Concepts are mental representations of objects, ideas, situations, or entities, constructed from individuals' direct or indirect experiences (e.g., through others' reports). Consequently, representations may include not only a conceptual core (i.e., defining or central features) but also associated subjective experiences when relevant to the concept's meaning (Murphy, 2010). Examples of such linked information include emotional evaluations (e.g., sadness, joy), moral judgments (e.g., good vs. bad), and contextual associations, such as the place or time when an event linked to the concept occurred.

Both concepts and their features are grouped with other items that share properties under higher-order concepts, thereby signalling broader conceptual domains. Langacker's (1987) notion of a domain of experience converges with Ashby and Reese (1995) in highlighting how context, beyond the immediate situation, shapes categorization. For instance, a knife may be construed as a kitchen tool or a weapon depending on the domain. Importantly, the process of categorization organizes concepts and, in doing so, structures the conceptual system itself (Banks et al., 2020).

Categorization processes become particularly relevant when examining concrete and abstract concepts, as the nature of the distinction between these domains remains unclear. The first ones (e.g., HOUSE) are characterized by clearly identifiable referents grounded in sensory and motor experience (Vigliocco et al., 2018), whereas abstract concepts (e.g., DEMOCRACY) rely primarily on ideational content and encompass complex features such as emotions, situations, and introspective states (Barsalou & Wiemer-Hastings, 2005; Desai et al., 2018). Understanding how these conceptual domains are represented at both the cognitive and neural levels has motivated extensive research aimed at elucidating the functioning of the conceptual system and language. This issue is difficult to resolve, given the heterogeneity of abstract concepts across domains (e.g., moral, numerical) and their varying degrees of abstraction (e.g., HOPE vs. CLEANLINESS) (Banks et al., 2020; Borghi et al., 2017; Wang et al., 2010).

Embodied cognition approaches argue that both concrete and abstract concepts engage sensorimotor experience, albeit to different degrees and modalities. Empirical evidence indicates that abstract concepts associated with specific modalities (e.g., motor or visual features) activate corresponding neural systems, supporting a modality-dependent account of conceptual processing (Borghi et al., 2017; Körner et al., 2023; Morey et al., 2022). Nevertheless, developmental and clinical data further suggest qualitative differences between abstract and concrete concept representations, although boundaries between these domains are often blurred. Emotional and numerical concepts, for example, challenge a strict dichotomy, supporting the view that concreteness is a continuous rather than categorical dimension. (Condry & Spelke, 2008; Pecher & Boot, 2011; Vigliocco et al., 2018)

Also, behavioral findings such as the concreteness effect demonstrate differences in the processing of concrete and abstract concepts (Bonner et al., 2009). This effect refers to superior performance in the processing of concrete concepts compared to abstract ones, with concrete concepts being retrieved and recognized more rapidly, likely due to richer semantic representations and greater imageability (Connell & Lynott 2018). In this sense, mental imagery resembles perceptual experience but unfolds without external sensory input (Wang et al., 2010).

A more comprehensive theoretical framework within Embodied cognition, the *Grounded Cognition Theory* (Barsalou, 2020; McRae et al., 2018) posits that conceptual knowledge is grounded in bodily experience as a whole. That is, it encompasses sensory, motor, and affective information, as well as the mental states in which an individual is situated when a concept is activated, thereby supporting representations of the external world.

Additionally, abstract concepts may be accessed via concrete ones through metaphorical and conceptual integration mechanisms, as described by *Conceptual Metaphor Theory* and *Conceptual Blending* (Coulson, 2001; Lakoff & Johnson, 1980). These processes allow concrete source domains to structure abstract target domains, facilitating abstract conceptualization.

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Theoretical framings mentioned above (*Grounded Cognition Theory, Conceptual Metaphor Theory,* and *Conceptual Blending)* seem not to be explicit in the role and interactions of the multiple modalities of the information updated when human beings conceptualize. Recent research has increasingly favored and highlighted the role of multimodal clues by suggesting hybrid and multimodal frameworks, proposing that abstract concepts may be grounded in linguistic, sensorimotor, affective, and interoceptive systems, either independently or in combination (Borghi et al., 2017; Harpaintner et al., 2020; Lynott et al., 2020). Earlier accounts, however, had already shown that single concrete cues can shape the understanding of abstract concepts through projection or mapping mechanisms. What remains less clear is whether conceptual processing is driven primarily by one salient cue at a time or whether the concurrent integration of multiple cues produces additional effects. In this sense, presenting concrete visual stimuli provides a useful way to test whether abstract conceptual processing is modulated by a single visual association or by the combined contribution of several visual features. Accordingly, the present study examines whether the simultaneous presentation of different visual features (color, shape, and spatial location) modulates the processing of abstract emotional concepts beyond the contribution of any single visual cue.

Shape. Research on shape-meaning associations has consistently demonstrated the Kiki/Bouba effect, whereby rounded shapes are preferentially matched with the pseudoword Bouba and angular shapes with Kiki. This robust crossmodal correspondence has been replicated across ages, cultures, and writing systems, suggesting that visual properties can be intuitively mapped onto phonetic features. Beyond sound symbolism, geometric properties themselves convey affective valence: curved contours are generally associated with positive emotions, whereas angular or sharp shapes elicit negative affect and threat-related responses. This preference is thought to have evolutionary origins, as angular forms are common in naturally occurring threats. Empirical evidence further shows that people attribute emotional meaning to basic perceptual features, and even neural threat-detection circuits are activated by angular shapes. Together, these findings support the idea that shape carries intrinsic affective meaning relevant to conceptual processing (Blazhenkova & Kumar, 2018; Ćwiek et al., 2022).

Color. Associations between color and emotion are widespread across cultures and languages, as reflected in common linguistic expressions linking colors to affective states (Littlemore et al., 2023). While some color-emotion mappings are culturally learned, substantial evidence suggests that many are grounded in shared cognitive or evolutionary mechanisms. Large cross-linguistic studies have identified both universal tendencies, such as red being more strongly associated with negative emotions and green with positive emotions, and systematic modulation by linguistic and geographic factors (Jonauskaite et al., 2020). Red is frequently linked to danger, anger, and threat, though also to love and passion, whereas green is commonly associated with positive valence, nature, and safety. Importantly, behavioral evidence shows that these associations can facilitate cognitive processing: responses to emotionally valenced concepts are faster and more accurate when negative concepts are presented in red and positive concepts in green, especially when these colors are contrasted (Kawai et al., 2023).

Space*:* Spatial dimensions, both horizontal and vertical, are systematically associated with affective valence, as reflected in linguistic metaphors and behavioral responses (De la Vega et al., 2012; Santiago et al., 2012). In the horizontal axis, positive valence is typically mapped onto the dominant side of the body, while negative valence is associated with the non-dominant side. Crucially, this mapping reverses depending on manual dominance, with right-handed and left-handed individuals showing opposite spatial–valence associations. Experimental evidence from adults, children, and neurological patients demonstrates that these effects are driven by motor fluency rather than cultural convention, supporting the *Body-Specificity Theory* (Casasanto, 2009; Casasanto & Chrysikou, 2011; Casasanto & Henetz, 2012; Willems et al., 2009). According to this account, sensorimotor experience shapes abstract evaluations, and widespread linguistic patterns (e.g., right-good, left-bad) likely emerge from population-level right-handedness rather than intrinsic spatial meaning. These findings underscore the role of embodied experience in abstract conceptualization.

The preceding discussion suggests that conceptualization involves multiple sources of input, including ideas, sensory information, actions, and language. Consequently, the processing of abstract stimuli should be mediated by crossmodal correspondences associated with these inputs. For this reason, the present study examines the potential effects of concrete visual stimuli on the processing of the valence of abstract emotional concepts. The aim is to contribute to the ongoing debate on the role of concrete concepts in the conceptualization of abstract ones, and, more broadly, to our understanding of how humans conceptualize.

Methods

Ethics statement, openness, and reproducibility

The research followed established ethical procedures for human subjects research, consistent with institutional and national guidelines. All experimental materials, scripts, data, and application code generated during this study are available at https://osf.io/4ecmu/overview?view_only=bfabfa13bcc945e78de3e0b9d072d4a0

Participants

Forty participants (27 women), aged 18-52 years (*M* = 27.9, *SD* = 6.9), took part in the study. The sample consisted predominantly of right-handed individuals (4 left-handed), all native Spanish speakers and Uruguayan nationals Participants were recruited through the research center's volunteer database, social media advertisements, and undergraduate courses at the Faculty of Psychology.

Materials

For the construction of the experimental task, we used the normed adjectives reported by Stadthagen-González et al. (2018; see Table 11). From that database, we selected items with positive (24 adjectives, i.e. ADMIRABLE), neutral (12 adjectives, i.e. DOMESTIC), and negative (24 adjectives, i.e. PAINFUL) valence. No additional control was applied for lexical variables such as frequency or familiarity, as these were not systematically matched in the source database, where such control is acknowledged as a goal for future work.

The images employed corresponded to all combinations of the three concrete referents under study: Kiki and Bouba (shape), colored red or green (color), and presented on the left or right (spatial position). Thus, each adjective was presented eight times, once for each concrete referent. Neutral items were used as filler stimuli and were not included in the analyses.

Procedure

The experiment consisted of a dual-stimulation task, specifically an adaptation of the picture-word interference paradigm (Glaser & Düngelhoff, 1984). Presenting a word alongside an image creates a compound stimulus that combines linguistic and graphical features. This combined stimulus produces effects analogous to those observed in the Stroop task, in which concrete referents (shape, color, and spatial position) serve as distractors, thereby inducing interference in the processing of the target word.

Participants were informed, both in the written information sheet describing the task and at the beginning of the experimental session, that they were required to indicate whether the concept presented on the screen was negative, neutral, or positive. Each trial began with a 300-ms fixation point, followed by the word-picture pair (the response target), which remained on the screen until participants responded to the valence of the presented adjective (see Figure 1). The interstimulus interval was filled by the presentation of a fixation point for a duration ranging from 2500 to 2700 ms, after which the initial fixation point was presented again.

At the beginning of each experimental session, participants completed a practice block consisting of 20 stimuli randomly selected from Table 1(he complete versions of Tables 1, 3, 4, and 5 can be found in the supplementary materials on OSF linked in the Ethics statement openness, and reproducibility). Unlike the experimental task, this block included positive and negative feedback after each trial. Subsequently, participants completed two blocks of 240 trials each, presented in a randomized order, with a rest break between blocks.

The break duration was self-paced, with a minimum of 30 seconds. Overall, the experimental session comprised 192 trials with positive-valence linguistic stimuli, 192 with negative-valence stimuli, and 96 with neutral-valence stimuli. The latter served as an attentional control condition. Accordingly, the study yielded 1,920 observations per congruency condition (40 participants x 24 items x 2 congruency conditions), which, according to Brysbaert and Stevens (2018), provides statistical power exceeding 80% to detect an effect size of 16 ms.

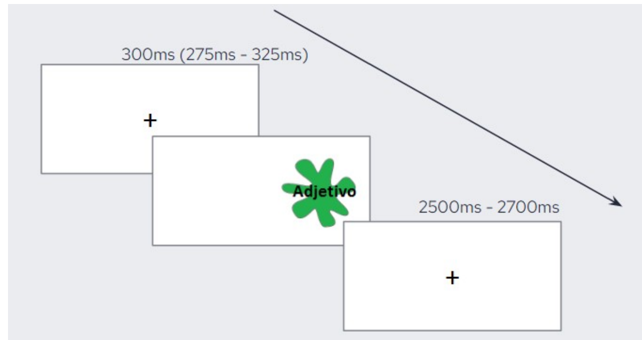

Figure 1: *Stimulus Temporal Sequence.*

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The experimental sessions were conducted in a sound-attenuated room at the Basic Experimental Psychology Laboratory of the Faculty of Psychology, University of the Republic. The experiment was programmed using PsychoPy (version 2.02.02). Responses were collected using a QWERTY computer keyboard, on which two paper labels, one marked with a "+" and the other with a "–", covered the response keys "A" and "L", respectively. Half of the participants responded to positive adjectives with the "A" key and to negative adjectives with the "L" key, while the other half used the opposite key assignment. Neutral adjectives were responded to using the space bar.

At the end of the experimental task, participants rated the eight images (corresponding to the different combinations of shapes, colors, and spatial positions) used as concrete stimuli, in the absence of adjectives, on a five-point scale ranging from 1 (negative) to 5 (positive). These ratings were collected to assess the valence of each image as perceived by participants.

Statistics design

An ordinal mixed-effects regression analysis was conducted using a cumulative link mixed model (CLMM) with logit link function to examine participants' ratings of the stimuli. The model included shape, color, and spatial location, as well as their interactions, as fixed effects, and random intercepts and slopes by participant (clmm(rating ~ shape * color * space + (shape + color + space | participant); Random slopes were specified additively rather than interactively because models including interaction terms failed to converge. Post hoc pairwise comparisons were performed using estimated marginal means with Tukey-adjusted p values.

A Generalized Linear Mixed Model (GLMM) approach was conducted to assess the presence of variations in accuracy (ACC) as a function of the independent variables and their interactions: Adjective Valence (Negative vs. Positive) x Shape (Kiki vs. Bouba) x Color (Red vs. Green) x Spatial Position (Left vs. Right).

The model was specified as follows:
glmer(ACC ~ ValenceC x SpaceC x ColorC x ShapeC + (1 | Subject) + (1 | Item)), where ACC represented accuracy and Item referred to the adjective presented on each trial.

The same independent variables and interaction structure were included in a Linear Mixed Model (LMM) to analyze reaction times. The corresponding model was: lmer(logRT ~ ValenceC x SpaceC x ColorC x ShapeC + (1 | Subject) + (1 | Item)), with the base-10 logarithm of reaction time (logRT) as the dependent variable instead of accuracy. All predictors were centered and recoded prior to analysis.

All analyses were conducted using RStudio (version 2026.01.0; RStudio Team, 2026). The lme4 package and lmerTest (version 3.1-2) were used to fit the mixed-effects models and to obtain inferential statistics. The emmeans package (version 1.5-1) was employed to compute estimated marginal means and to perform post hoc comparisons with Bonferroni and Tukey corrections. Finally, the rsq package (version 2.1) was used to estimate the proportion of variance explained by each model.

Results

A cumulative link mixed model revealed significant main effects of shape and color on valence ratings. Kiki shapes were associated with lower ratings than Bouba shapes (β= -2.81, p<.001), and red stimuli yielded lower ratings than green stimuli (β= -4.14, p<.001). No main effect of spatial location was observed (β=0.02, p=.967). A marginally significant interaction between shape and color was found (β=-1.47, p=.054), whereas interactions involving spatial location were not significant. Pairwise comparisons indicated that Bouba-green combinations received the highest ratings, whereas Kiki-red combinations received the lowest. Specifically, Bouba-green stimuli were rated significantly more positively than Kiki-green, Bouba-red, and Kiki-red stimuli (p=.005). Likewise, Kiki-red stimuli differed significantly from all remaining combinations (all p<.001); see table 2 and 6.

Table 2. Cumulative Link Mixed Mode

Reference	Estimate	SD	Z	*P*
kiki	-2.809	0.809	-3.470	< .001
red	-4.135	0.842	-4.907	< .001
right	-0.021	0.522	0.042	0.966
kiki-red	-1.467	0.762	-1.926	0.054
kiki-right	0.846	0.698	1.212	0.225
red-right	-0.188	0.696	-0.271	0.786
kiki-red-right	-1.067	1.027	-1.040	0.298

NOTE: Coefficients represent comparisons against the reference levels shown in the first column.

Accuracy

Only one participant was excluded from the analyses for registering an error rate exceeding 20%. In the figures presented below, error bars represent ±1 standard error of the mean. Asterisks indicate significance levels (*p < .05, **p < .01, *p < .001). Table 3 reports accuracy by experimental condition.

The GLMM specified for accuracy (see Table 4), which included random intercepts and slopes for participants and items, converged successfully. Following recommendations by Barr (2013) and Meteyard and Davis (2020), the model specification is appropriate for this type of design. The model accounted for R^2 = .015 (fixed effects) and R^2 = .331 when random effects were included. As shown in Table 4, there was a significant interaction between image color and adjective valence. Holm–Bonferroni–adjusted post hoc tests on estimated marginal means (emmeans) revealed that accuracy increased when red was paired with negative adjectives (p < .001) and when green was paired with positive adjectives (p = .016) (see Figure 2). Table 3 shows that stimuli with a positive adjective and the color green had accuracy above the mean, whereas those in red were below the mean (except for the Kiki-red-right stimulus, which was also above the mean). Conversely, stimuli containing the color red and a negative adjective showed accuracy above the mean, while those in green were below the mean.

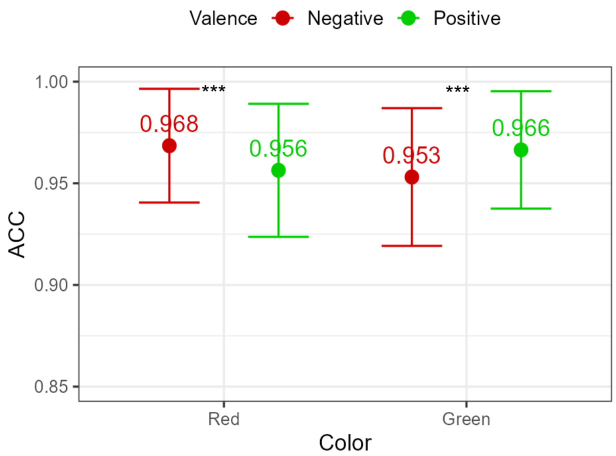

Figure 2. Accuracy by adjective valence and stimulus color.

Reaction times

Failed trials were excluded from the RT analyses; these constituted 3.9% of the valid data. Trials with RTs greater than 2500 ms were subsequently removed. The cut-offs were set by visual inspection of the reaction time (RT) distribution, at points where it was leveling off, with the preestablished requirement of not leaving out more than 5% of correct trials. Fixed cut-offs are a standard way to deal with outliers and they have both advantages and disadvantages when compared with other methods (Ratcliff, 1993).

Because RT distributions violated normality according to the Kolmogorov–Smirnov test ($p < .001$), RTs were transformed using the base-10 logarithm to meet the normality assumption required for linear mixed modeling.

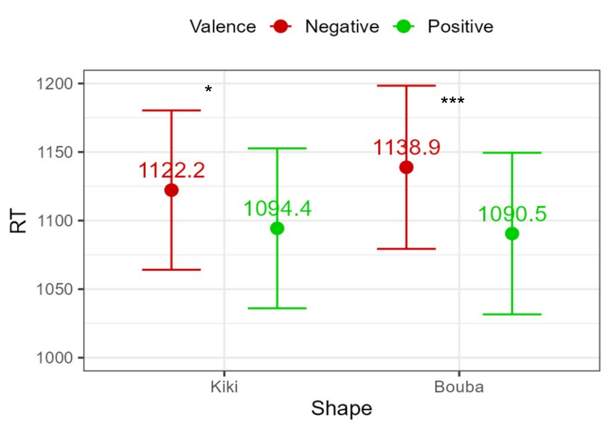

Figure 3. Reaction time by adjective valence and referent color.

As with the accuracy model, the LMM specified for log-transformed RTs (see Table 5), which included random intercepts and slopes for participants and adjective valence, also converged successfully. This model accounted for R^2 = .011 (fixed effects) and R^2 = .379 including random effects. Table 5 shows significant main effects of spatial position (p = .034), color (p < .001), and adjective valence (p = .010) on response latencies. Post hoc comparisons revealed a significant effect of valence, with faster responses to positive than negative stimuli (estimate = 0.016, p = .007) and in color, with faster responses to green (estimate = 0.015, p < .001). As these effects were not anticipated, it is addressed in the Discussion, where it is considered in relation to the findings described below.

Further, a significant shape x valence interaction was observed (p = .035). Bonferroni-adjusted post hoc comparisons indicated that latencies were shorter when participants responded to positive adjectives in the presence of a Bouba (estimate = 0.019, p = .001) and kiki stimulus (estimate = 0.012, p = .050). For the significant color x valence interaction (p < .001), post hoc tests indicated that latencies were reduced only when a positive adjective was presented with a green stimulus (p < .001) (see Figure 4). The same facilitation pattern was also observed for accuracy.

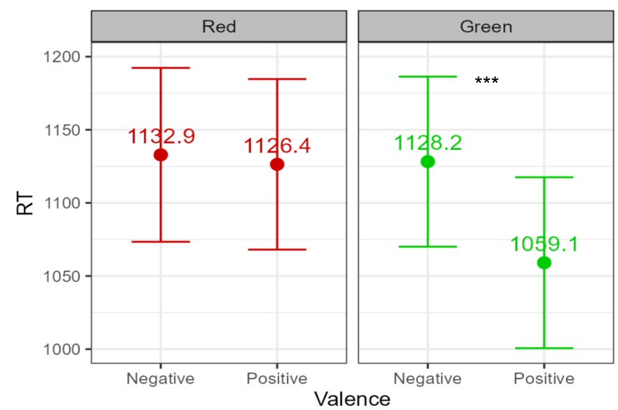

Figure 4. Reaction time by adjective valence and shape.

Discussion

The present study investigated, using a picture-word interference task, how concrete visual referents (Shape, Color, Space) affect the processing of emotionally valenced abstract concepts. The results revealed differentiated effects across cues rather than a clear additive congruency pattern, indicating that concrete referents did not contribute equally to abstract concept processing. More importantly, they reveal that the concurrent presentation of multiple congruent visual cues, specifically color and shape, modulates abstract concept processing. While the general idea of multiple congruency within a single modality is not new in itself, the novelty of this study lies in applying this approach to the specific combination of Bouba/Kiki shapes, red/green colors, and left/right spatial positions in relation to emotional valence. According to the associations between valence and each perceptual cue described in the Introduction, congruency effects were expected to emerge for each cue independently. Additionally, it was hypothesized that combining congruent cues could produce an additive facilitation effect, such that Bouba–green–right stimuli would maximally facilitate positive adjectives, whereas Kiki–red–left stimuli would maximally facilitate negative adjectives.

First, a significant interaction between Shape and adjective valence was found. Critically, reaction times were reduced for positive adjectives in the presence of Bouba, but a similar facilitatory trend was also observed for positive adjectives with Kiki, although the magnitude of the effect was larger for Bouba (table 5, figure 3). This pattern suggests that both shapes facilitate positive valence processing, rather than Bouba being uniquely positive. This nuanced finding should be directly acknowledged: the shape-valence mapping is not binary but graded, and theoretical accounts need to explain why both shapes show facilitation for positive stimuli, with Bouba showing a stronger effect. One possibility is that the general facilitation associated with positive valence overshadowed finer-grained shape-valence correspondences, leading to a more uniform speed-up across shape conditions. Notably, this effect did not extend to color-based interactions, suggesting that valence-driven facilitation may operate somewhat independently from color congruency in the present design.

Second, the findings indicate that accuracy was influenced exclusively by Color in interaction with adjective valence (Figure 2 and Table 4), yielding higher accuracy when the valence of both stimuli was congruent (red-negative; green-positive). This interaction was also observed for reaction times; however, post hoc analyses showed that RT reductions occurred only when the color green was presented together with a positive adjective (i.e., a congruent association), with no corresponding facilitation for the red-negative pairing (see Table 5 and Figure 4). Taken together, the evidence supports the claim that Color facilitated the processing of abstract-concept valence, as indicated by both accuracy and reaction times, although the latter was affected only in the positive-congruent condition.

The spatial location of the pictorial stimulus, defined as Space, did not modulate either accuracy or reaction times as a function of adjective valence (Tables 4 and 5). In line with this result, participants' stimulus ratings showed no differences between figures that shared the same color and shape but differed in spatial position (Table 2). That is, stimuli such as red-Kiki were rated almost identically regardless of whether they appeared on the left or the right. These findings suggest that spatial position was not a salient parameter for participants. Accordingly, the present study does not provide evidence for an effect of this concrete referent on the processing of emotionally valenced abstract concepts.

In this respect, participants' ratings become particularly relevant, as they appear to anticipate the patterns observed in both accuracy and reaction times. As shown by the CLMM results (Table 2), significant differences in ratings emerged for shape (β= -2.809) and, with a larger effect size, for color (β= -4.135). These findings suggest that color elicited a stronger association with emotional valence and exerted a greater influence on processing, consistent with the behavioral effects observed in accuracy and reaction times.

Another relevant finding is the absence of three-way or four-way interactions, such as space x color x valence, shape x color x valence, or shape x color x space x valence. Although no prior studies directly examine such higher-order interactions, two recent studies have explored associations involving two or three concrete entities. Lin et al. (2021) reported that angular shapes tend to be associated with the color red and negative emotional valence, whereas rounded shapes are linked to positive valence. Similarly, Metatla et al. (2019) found associations between scents, shapes, and emotions in children.

With respect to the statistical models, the marginal variance explained by both the GLMM and the LMM was substantially lower than the conditional variance (although the latter includes the former). This indicates that adjective valence, the concrete features of the stimuli (spatial position, color, and shape), and their interactions explain only a small proportion of the variance in accuracy and reaction times. Although the fixed effects significantly influenced performance, a substantial proportion of the variance was associated with participant- and item-level variability. This suggests that individual differences and linguistic characteristics also played an important role in task performance. This pattern is typical in mixed-effects modeling, as conditional variance reflects the combined contribution of all modeled sources of variability and aligns with expectations derived from the theoretical framework of this research. Although including these random effects improves model fit, future studies should consider increasing sample size to reduce unexplained variability or, alternatively, acknowledge that individual factors play a dominant role in this experimental design.

An additional methodological consideration concerns the specification of the statistical models. Including multiple independent variables with random slopes and intercepts for each predictor (i.e., a maximal model) resulted in convergence failures. Consequently, a model including random intercepts and slopes for participants and adjectives was selected, in accordance with recommendations in the literature (Barr, 2013; Meteyard & Davis, 2020), which emphasize balancing model complexity with the risk of overparameterization. A more exhaustive approach could involve testing a hierarchy of models, from the most complex to the simplest null model, and using ANOVA comparisons to determine the best-fitting specification. However, such an approach would require a substantially larger sample to avoid convergence issues and could be addressed in future research. In this context, while the sample size may constrain the detection of higher-order interactions across four factors, the study was designed to focus on theoretically motivated main effects and lower-order interactions. Accordingly, analyses and interpretations of higher-order interactions were treated as exploratory. Beyond these statistical considerations, the study design itself also imposes certain interpretative constraints. Neutral stimuli were included exclusively as fillers and were therefore not analyzed as an independent experimental condition. Consequently, the present design does not allow robust comparisons between neutral and valenced stimuli, particularly because neutral items represented only 1/5 of the total stimuli, whereas positive and negative stimuli each comprised 2/5 of the set. Future studies could systematically examine whether congruency effects differ between valenced and non-valenced stimuli, which may help clarify whether these effects are specific to emotional valence or reflect broader semantic processing mechanisms.

Although the sample was not fully gender-balanced (67% women), this limitation is not critical; however, given evidence that color and valence-based effects can interact with gender in categorization tasks (Gil & Le Bigot, 2015) , future research could examine potential gender differences in the present paradigm. Another limitation is that lexical variables such as frequency and familiarity were not explicitly controlled. This is relevant because prior evidence indicates that emotional valence can interact with lexical factors and influence early stages of word processing (Barriga-Paulino et al., 2022).

Conclusion

The present study provides evidence that concrete visual referents modulate the processing of emotionally valenced abstract concepts. Specifically, color and shape influenced behavioral performance, whereas spatial position showed no consistent effect. Congruent associations between green and positive valence, as well as between Bouba-like shapes and positive valence, facilitated processing, as reflected in accuracy and reaction times. In contrast, no robust evidence was found for a contribution of left–right spatial position to abstract emotional processing. These findings partially converged with participants' explicit ratings of the stimuli, with color emerging as the most salient cue and shape showing a weaker, although still significant, association with emotional valence. Overall, the results support the view that perceptual associations form part of the representation and online processing of abstract concepts. More broadly, the study suggests that concurrent visual cues can influence abstract conceptual processing, although their contributions are not necessarily additive and may differ in salience and behavioral impact.

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