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ORIGINAL ARTICLE

Relational Cues are Affectively Differentiated

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Abstract

The present study explored whether cues trained to specify relational (C_{rel}) or relational and functional ($C_{rel+func}$) control are differentially evaluated. If valences vary across $C_{rel+func}$ but not C_{rel} cues, the two cue types would be deemed functionally distinct, as posited by relational frame theory (RFT; McLoughlin et al., 2019). One hundred sixty-six participants, split into six groups, underwent matching-to-sample (MTS) training and testing to establish cues exerting C_{rel} (analogous to the phrases *more than* or *brighter than*) or $C_{rel+func}$ (analogous to the phrases *happier than* or *calmer than*) control. Besides MTS, cues were evaluated using visual analog scales, which revealed that valence magnitudes varied significantly across $C_{rel+func}$ *and* C_{rel} cues. In particular, cues specifying opposing C_{rel} poles (e.g., *more* vs. *less*), like cues specifying opposing $C_{rel+func}$ poles (*happier* vs. *unhappier*), evoked differential evaluations. This suggests $C_{rel+func}$ and C_{rel} control are functionally reducible to a single $C_{rel+func}$ category, implying the latter anticipates C_{rel} and C_{func} control, contra RFT. After highlighting the limitations inherent to "a-ontological" conceptualizations of contextual cues, we present an alternate take of cue properties derived from Amd's (2022) realist approach, which accounts for the present findings and suggests novel avenues for future research.

Keywords Symbolic learning · Relational cues · Relational frame theory · Valence · Behavioral realism

In daily communication, the interpretation of statements is often influenced by the relational cues they contain. For example, when presenting an English-speaking audience with the statement *John is happier than Bob*, *John* will likely be perceived more positively than *Bob*, assuming all other factors are held equal. In this instance, the expression *is happier than* serves as a contextual cue that simultaneously conveys information about the functional dimension (C_{func}) and the specific type of relationship (C_{rel}) established between *John* and *Bob* (Amd & Roche, 2015). To clarify the distinction between these "functional" and "relational" properties, we can rephrase the initial statement to *John is more happy than Bob*. Here, *is more . . . than* indicates the comparative relationship, and *happy* specifies the relevant functional dimension. Amd and Roche (2015, 2016, 2017) conducted a series of studies demonstrating how relation-specifying (*is more . . . than*) and function-informing (*happy*) elements of contextual cues guide the interpretation of symbols related in their presence, similar to how *happier than* influences the comparative assessment of *John* relative to *Bob*, all else being equal.

The differentiation between relational (C_{rel}) and functional (C_{func}) aspects of contextual cues is asserted by relational frame theory (RFT), a behavior-analytic account of symbolic behavior (Hayes et al., 2001; McLoughlin et al., 2019). RFT posits that cues indicating a relationship between terms (exercising C_{rel} control) but not specifying any functional dimension (lacking C_{func} control) can produce coherent yet essentially "meaningless" propositions (Hayes et al., 2001, p. 58). For instance, both *John is more happy than Bob* and *John is more than Bob* are coherent statements, given the phrase *is more . . . than* applies comparative C_{rel} control in both cases. However, only the first statement includes C_{func} control (through the use of *happy*), rendering it a "meaningful" proposition (Hayes et al., 2001, p. 57). Presuming C_{rel} and C_{func} control are jointly essential for imbuing symbols with meaning, Amd and Roche (2015) proposed that contextual cues could be conceptualized as $C_{rel+func}$ cues to reflect their application more accurately. In the example *John is happier than Bob*, the phrase *is happier than* would be considered a $C_{rel+func}$ cue, with the

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components *happi-* and *-er* signifying C_{func} and C_{rel} control respectively.

The claim that contextual cues exert *combined* relational and functional ($C_{rel+func}$) control was a significant contribution of the study by Amd and Roche (2015), which focused on how the emotional valences of stimuli are transformed in the presence of contextual cues exerting either relational control alone (C_{rel}) or combined relational and functional ($C_{rel+func}$) control. The decision to establish contextual cues trained to specify relational (*more-* vs. *less-than*) control exclusively, alongside cues that combined relational control with an affective (*happy* vs. *unhappy*) functional dimension, was a key innovation of that study. Those authors reported that stimuli related in the presence of $C_{rel+func}$ cues had their emotional valences significantly affected, relative to stimuli related in the presence of C_{rel} cues. In simpler terms, that work showed how appraising a *X is happier than Y* statement tends to generate more positive assessments of *X* over *Y*, compared to appraisals of a *X is more than Y* statement, seeing how the former explicitly outlines the functional dimension (C_{func}) qualifying the comparative relation. That work illustrated the complex interaction between relational (C_{rel}) and functional (C_{func}) dimensions towards shaping the emotional significance of stimuli, culminating in the conceptualization of $C_{rel+func}$ cues.

The notion that contextual cues exert $C_{rel+func}$ control poses an important theoretical question: Does $C_{rel+func}$ control emerge from the separate contributions of C_{rel} and C_{func} control, or is it the other way around? More broadly, does the manifestation of combined relational plus functional control presuppose distinct levels of relational and functional stimulus control, or vice versa? This discussion is critical for RFT, which posits C_{rel} and C_{func} control as foundational constructs when describing contextually controlled stimulus relations. RFT suggests that symbolic relationships between arbitrary elements (call these: A and B) can be represented as either C_{rel}\{A r B\} to imply relational control, or as C_{func}[C_{rel}\{A r B\}] to indicate when a specific functional dimension is present (Mcloughlin et al., 2019). Inherent to both formulations is the assumption that C_{rel} and C_{func} control are functionally distinct priors whose combinations define the characteristics of contextual cues during symbolic behavior. If this assumption can be empirically supported, it would reinforce a core tenet of RFT, the separability of C_{rel} and C_{func} control, affirming their foundational status in the theory's conceptual structure.

Should C_{rel} and C_{func} control *not* be functionally distinct however, they might be posterior derivations of a unified $C_{rel+func}$ control concept. This would indicate that the latter, integrated form, constitutes the foundational concept from which simpler, individual forms have been derived. The distinction between "prior" and "posterior" hinges on whether complex cue-controlling properties evolve from more straightforward controls, or whether simpler controls represent conceptual reductions derived from more integrated forms of contextual control. In the latter scenario, both C_{rel}\{A r B\} or C_{func}[C_{rel}\{A r B\}] relations can be reclassified as instances of $C_{rel+func}$[A r B] relations. Furthermore, if contextual cues inherently exert relational and functional control, the subscript becomes superfluous, further simplifying $C_{rel+func}$[A r B] to C[A r B], or more succinctly, A r_c B. This reformulation, summarized in Table 1, accomplishes two objectives: first, it describes how C_{rel} and C_{func} controls are posterior derivations from a more comprehensive $C_{rel+func}$ category. Second, it posits that a "contextually controlled stimulus relation," succinctly represented as A r_c B, as functionally equivalent to a "proposition," which encapsulates any [term-relation-term] structure (Holt, 1914). These insights, if accurate, would necessitate a revision in the RFT conceptualization of contextual cues alongside a critical reassessment of its' foundational significance in understanding symbolic learning and its practical applications. These points will be returned to in the final Discussion.

By now, the importance of distinguishing between cues specifying $C_{rel+func}$ and C_{rel} control for accurately conceptualizing contextual cue operations should be evident. If C_{rel} is prior to $C_{rel+func}$ control, only cues exerting $C_{rel+func}$ control

Table 1 Overview of contextual cue properties

Concept	Definition	Functionally equivalent to . . .	Reason
C_{rel}	Controls relational aspects between stimuli.	$C_{rel+func}$	Relations presupposes terms sharing a common functional dimension.
$C_{rel+func}$	Unifies relational and functional control aspects.	C	If inseparable, the distinction between "rel" and "func" becomes redundant.
C	Contextual cue.	C_{rel}, C_{func}, and $C_{rel+func}$	Cues exert relational and functional aspects holistically.

C_{rel} represents the control of relational aspects between stimuli sharing a common functional dimension. If C_{rel} and C_{func} control is inseparable across cues as a rule, they unify as $C_{rel+func}$, which can be further reduced to C. The latter captures the integrated properties of relational and functional contextual control should be functionally distinct, but not cues exerting C_{rel} control as the latter lacks any explicit functional components (C_{func}s). On the other hand, if C_{rel} derives from $C_{rel+func}$ control, cues exerting C_{rel} or $C_{rel+func}$ control would be operationally indistinguishable from $C_{rel+func}$ cues.

This leads to a binary possibility: either a C_{rel} cue, trained to specify discriminations along purely relational dimensions (e.g., *more-than* or *brighter than*), is functionally distinct from a $C_{rel+func}$ cue, which specifies both relational and functional control (e.g., *happier-than* or *calmer-than*), or it is not. This hypothesis was examined by evaluating contextual cues trained to exert relational (C_{rel}) or relational plus functional ($C_{rel+func}$) control. In particular, we estimated valence differences for cues indicating opposite relational "directions" (→ vs. ←), such as *more* vs. *less*, *brighter* versus *darker*, or *happier* versus *unhappier*. The directional arrows (→ and ←) denote cues capable of specifying functionally equivalent relations (e.g., *A is more than B = B is less than A*) which are also distinct (*more ≠ less*) as they guide relational specifications towards opposite "directions" (→ ≠ ←). These arrows elucidate how the comparative relations under investigation, even without explicit affective content, may still evoke differential evaluations based on their implied directionality.

To illustrate this concept, envision a participant is presented with a sample cue alongside two comparison images that differ in dot quantity, employing a MTS paradigm similar to Amd and Roche (2015). When the sample is designated to signify a *more-than* cue, selecting the image with a greater number of dots is positively reinforced through corrective feedback. Alternatively, selecting the image with fewer dots is reinforced when a *less-than* cue is the sample. In this manner, *more-than* and *less-than* cues represent opposite "relational directions" (← and →) along a shared C_{func} dimension of "dot quantity." By maintaining C_{func} control as a constant, any observed variations in cue-related effects can be attributed primarily to C_{rel} control. If the ability to discriminate between greater (fewer) dots in the presence of *more-than* (*less-than*) cues persists without corrective feedback, the successful establishment of C_{rel} control may be inferred (Amd & Roche, 2015). It is important to note that because the C_{func} component across comparisons was kept constant, any differences in performance would necessarily follow participants' understanding of the cues' implied relational directions (*more-than*, or →; and *less-than*, or ←).

The current study investigated whether cues trained to specify C_{rel} and $C_{rel+func}$ control, respectively marked by (→) and (←), elicited differential evaluations (refer to Table 2). On the one hand, it could be hypothesized that (→) and (←) cues, when specifying $C_{rel+func}$ control (e.g., *happier* vs. *unhappier*), would elicit distinct evaluations, as the explicitly incorporated C_{func}s of *happi-* and *unhappi-* inherently suggest positive and negative valences respectively. The critical inquiry is whether cues devoid of affective C_{func}s, such as those controlling for *more-* and *less-than* relations, or *brighter-* and *darker-than* relations, would produce comparable outcomes. Identifying valence differences exclusively among $C_{rel+func}$ cues, but not C_{rel} cues, would support the RFT assertion that C_{rel} (and consequently, C_{func}) control operate as isolable explanatory priors. On the other hand, should C_{rel} cues evoke differential evaluations akin to $C_{rel+func}$ cues, this might imply a prior *affective* dimension integral to both cue types.

Table 2 Cue Types Established Using Matching-to-Sample

Group	Cue1→ / Cue2←*	C_{rel}**	$C_{rel+func}$**
G1	More / Less	X	
G2	Brighter / Darker	X	
G3***	More | Less / Brighter | Darker	X	
G4	Happier / Sadder		X
G5	Aroused / Calmer		X
G6***	Happier | Aroused / Sadder | Calmer		X

* Relational control established for each cue, with → and ← representing opposite directions. For example, G1 underwent MTS trials designed to establish Cue1 with *more-than* (→) control, and Cue2 with *less-than* (←) control

** Cues trained to specify relational (C_{rel}) or relational plus functional ($C_{rel+func}$) control

*** G3 viewed comparison terms from G1 and G2, and G6 viewed comparison terms from G4 and G5

In this study, all established C_{rel} cues represented opposing relational directions (*more-* vs. *less-than*, *brighter-* vs. *darker-than*) along common C_{func} dimensions that were affectively neutral. Furthermore, all established $C_{rel+func}$ cues specified opposing directions that varied explicitly along affective C_{func} dimensions (*happier-* vs. *unhappier-than*, *aroused* vs. *calmer-than*). The selection of these dimensions drew partly on prior research demonstrating that comparative and affective contextual control can be effectively established within laboratory settings. Earlier studies focused on establishing contextual cues and then deploying them to "transform" targeted symbolic properties, such as the affective valences of related terms (Amd, 2014; Dougher et al., 2007; Munnelly et al., 2019). For instance, consider how phrases like *happier than* (or *unhappier than*) might "transform" the valences of *John* relative to *Bob* following assessment of the proposition *John is happier than Bob* (or *Bob is unhappier than John*) ceteris paribus. Although previous research focused on the effects of terms related in the context of such cues (e.g., *John* and *Bob*), the current study investigates whether the valences of the cues themselves (*happier* vs. *unhappier*) become influenced.

The present objective was to ascertain whether cues trained to specify relational (C_{rel}) or relational plus functional ($C_{rel+func}$) control would come to elicit differential evaluations. Undergraduate participants were divided into six groups (G1:G6; refer to Table 2), each undergoing a series of MTS training and testing trials to establish cues exerting either C_{rel} (G1:G3) or $C_{rel+func}$ control (G4:G6). Participants evaluated cue and distractor terms before and after MTS using Visual Analog Scales (VAS) with endpoints anchored by smiling and frowning cartoon faces (Amd et al., 2019). The MTS protocols were adapted from previous studies by Amd and Roche (2015, 2016, 2017).

During MTS trials, participants were presented with a sample stimulus (labeled Cue-1 or Cue-2), followed by two comparison stimuli, one of which was always "correct" in relation to the presented sample. The single parameter varied across groups was the content of the comparisons used during MTS, which determined the cue type to be established (C_{rel} or $C_{rel+func}$). Participants in Group 1 (G1) encountered comparisons consisting of varying quantities of black dots, with the selection of a greater (or lesser) quantity reinforced in the presence of a *more-than* (or *less-than*) cue. Group 2 (G2) participants were presented with comparisons of different shades of grey squares, where choosing the brighter (or darker) square was reinforced in the presence of *brighter-than* (or *darker-than*) cues. The choice to use black dots (G1), grey squares (G2), or both (G3) as comparisons aimed to isolate and foster C_{rel} control by maintaining constant C_{func} control. Thus, accurate inference of the target comparative relations necessitated considering both comparisons along the single physical dimension they varied.

Participants assigned to Group 3 (G3) viewed comparisons comprising different numbers of dots, similar to Group 1 (G1), or squares in varying shades of grey, akin to Group 2 (G2). The goal was to establish *more-than* | *brighter-than* and *less-than* | *darker-than* relational cues, respectively. Should the evaluative responses provided by participants in G1 and G2 indicate a null difference among cues, an analogous lack of difference would be anticipated for G3 (because cues would constitute compounded C_{rel}s). Conversely, should G1 and G2 participants differentially evaluate cues, it raises an intriguing theoretical question. It would be interesting to examine whether cues that denote relationships in terms of quantity and brightness impact evaluations when trained as compounded cues, as opposed to being trained separately in G1 and G2. RFT is agnostic with respect to evaluative responses potentially elicited by cues specifying C_{rel} or $C_{rel+func}$ control, whether independently or in combination (Amd & Roche, 2015; Hayes et al., 2001).

Remaining participant groups (G4, G5, G6) engaged in MTS trials designed to establish $C_{rel+func}$ cues. Here, C_{func} control was varied across comparisons deployed for groups G4 (happy/sad/calm faces), G5 (excited/calm faces), and G6 (all faces). In G4, participants were required to select the relatively happier (or unhappier) face in the presence of cues designated to exert *happier-than* (or *unhappier-than*) $C_{rel+func}$ control (Amd & Roche, 2016). In G5, participants were presented with calm and aroused face pairs, with selections favoring the more aroused (or calmer) face being differentially reinforced in the presence of cues designated to exert *aroused* and *calmer* $C_{rel+func}$ control. The cues in G4 and G5 signified relations across affective dimensions of valence and arousal, respectively, with notable valence differentials anticipated solely for G4 due to the exclusive variation along arousal in G5, which should not elicit valence differentials (see Materials). However, because G5 underwent training that assigned cues to specify opposing "relational directions" (*aroused* as →; *calmer* as ←), this might suffice for eliciting differential evaluations for reasons noted earlier. Participants in G6 were exposed to all face pairings, including happy/calm, sad/calm, aroused/calm, and happy/sad, to establish *aroused* | *happier than* and *calmer* | *unhappier than* cues, respectively. As indicated above, it could be theoretically interesting to determine whether compounded (relative to singular) $C_{rel+func}$ training influences cue evaluations.

In sum, the current study investigated whether instrumentally established C_{rel} and $C_{rel+func}$ cues produced differential evaluations when an affective C_{func} dimension was (not) present. Cue establishment was inferred from participants' performances in MTS test trials, similar to prior research (Amd & Roche, 2015). Shifts in cue affect were inferred from evaluations collected before and after MTS. Our analysis aimed to determine if the evaluative distinctions among relational cues (e.g., *more-* vs. *less-than*) corresponded to those among cues specifying both relational and functional dimensions (such as *happier-* vs. *unhappier-than*). If the specified "directions" of cues (→ vs. ←) influence their reported valence, then evaluative distinctions between *more-* and *less-than* cues would be expected to mirror those between *happier-* and unhappier-than cues. Otherwise, suppose explicitly emotional, functional components (C_{func}s) are pivotal for attributing valences to cues. In that case, a significant evaluative distinction might emerge between *happier-* and *unhappier-than* cues. Our investigation into valence differences among various cue types, after controlling for feedback and familiarity effects (as elaborated in the Results section), aims to discern whether the differentiation between relational control (C_{rel}) and functional (C_{func}) operates prior to, or is subsequently derived from, a unified $C_{rel+func}$ category.

Method

Ethics and Data Availability Statement

The supplementary file accompanying this manuscript includes all data and analysis scripts. The study was not preregistered. The university's Review Ethics Board (REB) approved all procedures reported in this study.

Participants

Over 6 months, 180 undergraduate students participated in the study and received compensation equivalent to US$5. Initial inspection of data revealed missing responses from 24 participants, who were subsequently dropped from analysis. The remaining sample (N = 166) was divided among the groups as follows: Group G1, n = 28 (22.6 ± 3.8 years; 13 females); Group G2, n = 26 (23.1 ± 4.3 years; 17 females); Group G3, n = 26 (21.5 ± 2.5 years; 14 females); Group G4, n = 28 (22 ± 3.1 years; 13 females); Group G5, n = 29 (22.7 ± 2.7 years; 16 females); and Group G6, n = 27 (21.5 ± 2.2 years; 15 females). A sensitivity analysis for a one-way analysis of variance (ANOVA) indicated a sample of n = 166 observations was sufficiently large for detecting small-to-moderate effects ($\eta_p^2 = .012$) with 80% power and a 5% alpha error rate. All tasks were completed within 20 min of experiment onset.

Materials

Four trigrams (ZIV/JOK/LAK/FAZ) were employed as cues/distractors throughout the study. Two trigrams were randomly selected as samples/cues (Cue1, Cue2). The remaining trigrams appeared during the evaluation phases only and functioned as distractors (Dis-1, Dis-2). C_{rel} and $C_{rel+func}$ control were assigned to meaningless trigrams to avoid interindividual variances inherent to natural language cues. Although English speakers might universally understand natural language phrases, such as the actual phrases *more-than* or *happier-than*, their usage across idiosyncratic contexts implies an intractable connotative variability (Berlyne, 1965, pp. 165–168). Avoiding natural phrases or direct instructions (telling participants what each cue was "supposed" to mean) mitigated the cueing of natural word-associated histories and demand characteristics (Corneille & Lush, 2023). Trigrams assigned to cue/distractor conditions were randomized between participants. All evaluations were made on 9-point visual-analog scales anchored by frowning (1) and smiling (9) cartoon faces (adapted from Amd et al., 2019). Comparison content varied by Group. In particular, participants allocated to G1, G2, and G3 viewed comparisons constituting black dots, numbering between 3 and 11 dots (Fig. 1, Panel C) and/or grey squares, varied between 110 and 230 lumens (Fig. 1, Pane D). Participants allocated to G4, G5, and G6 viewed comparisons of male or female faces with happy, calm, aroused/excited, and sad expressions (Fig. 1, Panels A and B). Faces were taken from the Karolinska face database (Lundqvist et al., 1998) and selected based on mean ± SD valence (VAL) and arousal (ARO) ratings provided by 22 participants from an unrelated study. This included the same five faces with happy (VAL = 6.8 ± 2.3; ARO = 5.7 ± 2.7), sad (VAL = 2.1 ± 1.9; ARO

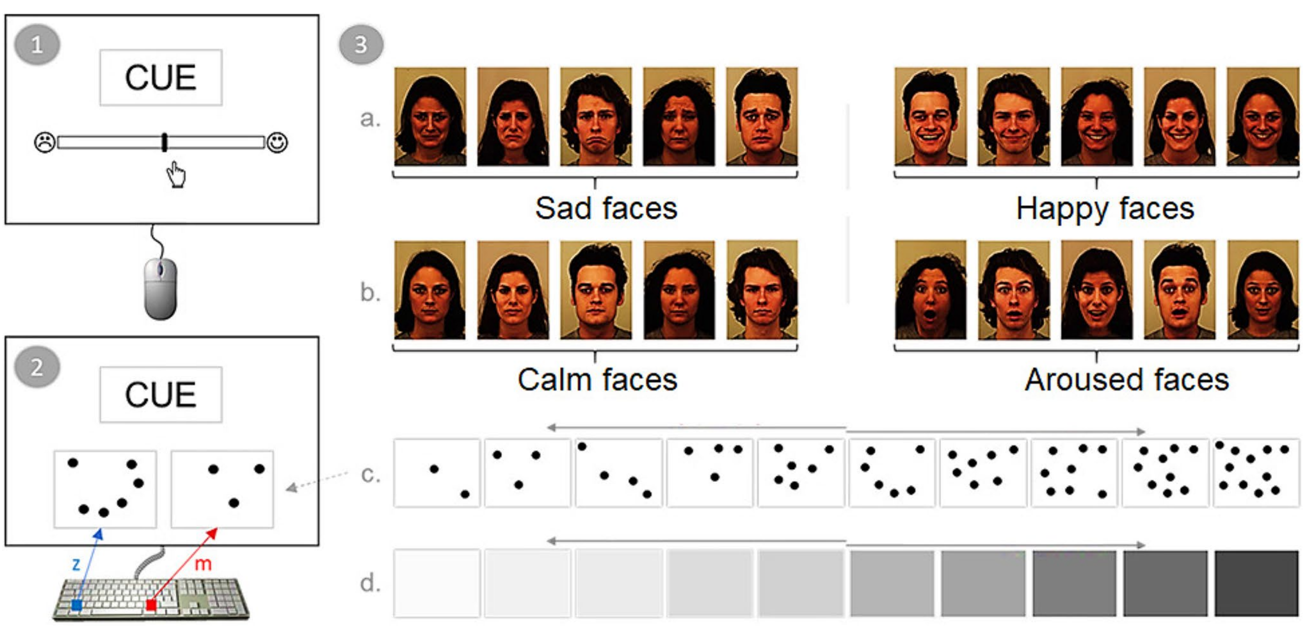

Fig. 1 All participants evaluated trigrams using visual-analog scales (Panel 1), before and after Matching-to-Sample Trials (Panel 2). All stimuli used in the current study are illustrated in Panel 3. Participants allocated to $C_{rel+func}$ conditions (groups G4, G5, and G6) viewed comparisons comprising of the same five faces varied along valence (Panel 3a) or arousal (3b). Participants allocated to C_{rel} conditions (groups G1, G2, and G3) viewed comparisons depicting different quantities of dots (3c) or shades of grey (3d)

= 5.7 ± 2.7), aroused/excited (VAL = 4.8 ± 2.1; ARO = 7.1 ± 1.8) and calm (VAL = 5.2 ± 2.3; ARO = 2.1 ± 1.4) expressions. All procedures were administered on E-Prime 3 (Psychology Software Tools, Inc., 2016). Analyses were run on *RStudio* (R Core Team, 2022) and utilized the following packages: *tidyverse* (Wickham et al., 2019), *apa* (Gromer, 2020), *ggplot2* (Wickham, 2016), *effectsize* (Ben-Shachar et al., 2020), *pwr* (Champely, 2020), and *rstatix* (Kassambara, 2023). Data and scripts for replicating reported analyses are available in the attached supplementary file.

Procedure

Each participant sat in front of a laptop in a quiet room for the duration of the study, under 30 minutes. All task phases were preprogrammed, with each phase's completion prompting the participant to notify the experimenter waiting outside to advance or terminate the task. Before commencing, all participants received a cover story informing them they were to view some "foreign words" during the upcoming MTS task, which they had to "figure out" the meaning of through trial and error. At task onset, all participants viewed the following instructions on screen (translated from Portuguese):

> Welcome! In the upcoming task, you will see a "foreign word" in the center of the screen. Please evaluate how Positive or Negative the presented word appears to you. Use the mouse to move the slider along the bar. If you think the word is more Negative, move the cursor to the Left. If you think the word is more Positive, move the cursor to the Right. You might not be sure whether the word could be Positive or Negative, and that is okay. In these cases, please give your best guess. Press the "Next" button after you have evaluated the word. You can press the spacebar when you are ready to begin. . . .

Pressing the spacebar commenced a four-trial evaluation phase (two cues, two distractors). Across each evaluation trial, a trigram in 18-point Arial black font appeared against a white background with a VAS underneath. Participants had to interact with the VAS to progress to the following trial/phase. VAS placements were scored along 9 points (from 1-negative to 9-positive). Completion of evaluation trials produced the following set of instructions:

> Now, you will perform a different task. You will see one of the words from the previous task near the top of the screen. Please pay close attention to this word. Afterward, you will see two images close to the bottom of the screen. One of these images will always be correct depending on which word appeared previously. To select the image on the left, press "z." To select the image on the right, press "m." You will first receive feedback on your response, telling you if it is "right" or "wrong." You will then have to continue responding without any feedback. When you are ready, press the spacebar to begin.

Pressing the spacebar produced an 80-trial MTS block of 60 training and 20 test trials. VAS and MTS phases appeared across separate contexts to minimize interference from context-specific rules (Högden et al., 2020). In each MTS trial, one of two trigrams appeared near the top half of the screen and was followed approximately half a second later by two comparisons near the screen's bottom left and right sides. Comparisons remained on the screen until the participant selected emitted a location-specific keypress ("z" or "m" for left or right comparisons, respectively). The feedback "Correct" was displayed for 2,000 ms during training trials if the sample-comparison mapping was accurate. Otherwise, a red X was displayed for 2,000 ms. All responses were followed by a blank 2,000 ms interval during test trials. Both sample trigrams appeared with equal frequency over the 80-trial MTS block. Designated cue functions varied among groups (Table 2) and were contingent on group-specific comparisons.

Participants assigned to G1 viewed comparisons depicting different quantities of dots (Fig. 1, Panel 3D) to establish *more-than* and *less-than* cues. Participants assigned to G2 viewed comparisons depicting grey squares of varying luminosities (Panel 3C) for establishing *brighter-than* and *darker-than* cues. Participants allocated to G3 viewed comparison pairs depicting different numbers of dots (similar to G1) or squares in different shades of grey (similar to G2) to establish cue-pairs that functioned as *more* | *brighter than* and *less* | *darker than*, respectively. Participants assigned to G4 viewed comparisons depicting the same person's face with happy/calm, sad/calm, or happy/sad expressions (Panel 3A) for establishing *happier-than* and *unhappier-than* cues. Participants assigned to G5 viewed comparisons depicting the same person's face with aroused/calm expressions (Panel 3B) for establishing *aroused* and *calm* cues. Cues for G4 and G5 specified relations across affective dimensions of valence and arousal, respectively. Finally, participants allocated to G6 viewed happy/calm, sad/calm, aroused/calm or happy/sad face pairs to establish *aroused* | *happier than* and *calmer* | *unhappier than* cues, respectively.

To sum up, C_{rel} cues were trained to specify relations along nonaffective dimensions across G1 [Cue1→*more dots*; Cue2→*fewer dots*], G2 [Cue1→*brighter square*; Cue2→*darker square*] and G3 [Cue1→*more dots/brighter square*; Cue2→*fewer dots/darker square*]. $C_{rel+func}$ cues were trained to specify relations along affective dimensions across G4 [Cue1→*happier face*; Cue2→*sadder face*], G5 [Cue1→*aroused face*; Cue2→*calmer face*], and G6 [Cue1→*happier/aroused face*; Cue2→*sadder/calmer* *face*]. Cue establishment was inferred from participants' performances during MTS test trials (Amd & Roche, 2015). Task-related shifts in cue valences were inferred from VAS evaluations collected before and after MTS.

Results

Matching-to-Sample Performances

All participants completed 60 training and 20 test trials during MTS. The mean proportion of accurate responses generated during test trials across individual participants is summarized in Fig. 2, Panels A and B. A performance disparity was evident among groups undergoing C_{rel} (G1, G2, G3) or $C_{rel+func}$ (G4, G5, G6) training (Panel A). Participants undergoing C_{rel} training in the presence of dots (G1), squares (G2), or both (G3) produced mean (SD) accuracies of 0.72 (0.17), 0.76 (0.21), and 0.76 (0.19), respectively. Participants who underwent $C_{rel+func}$ training in the presence of faces varied along happiness (G4), arousal (G5), or both (G6) produced mean (SD) accuracies ranging from 0.47 (0.06), 0.47 (0.05), and 0.46 (0.05), respectively. The pattern of results suggests that the establishment of C_{rel} control was more probable than the establishment of $C_{rel+func}$ control, paralleling Amd and Roche (2015).

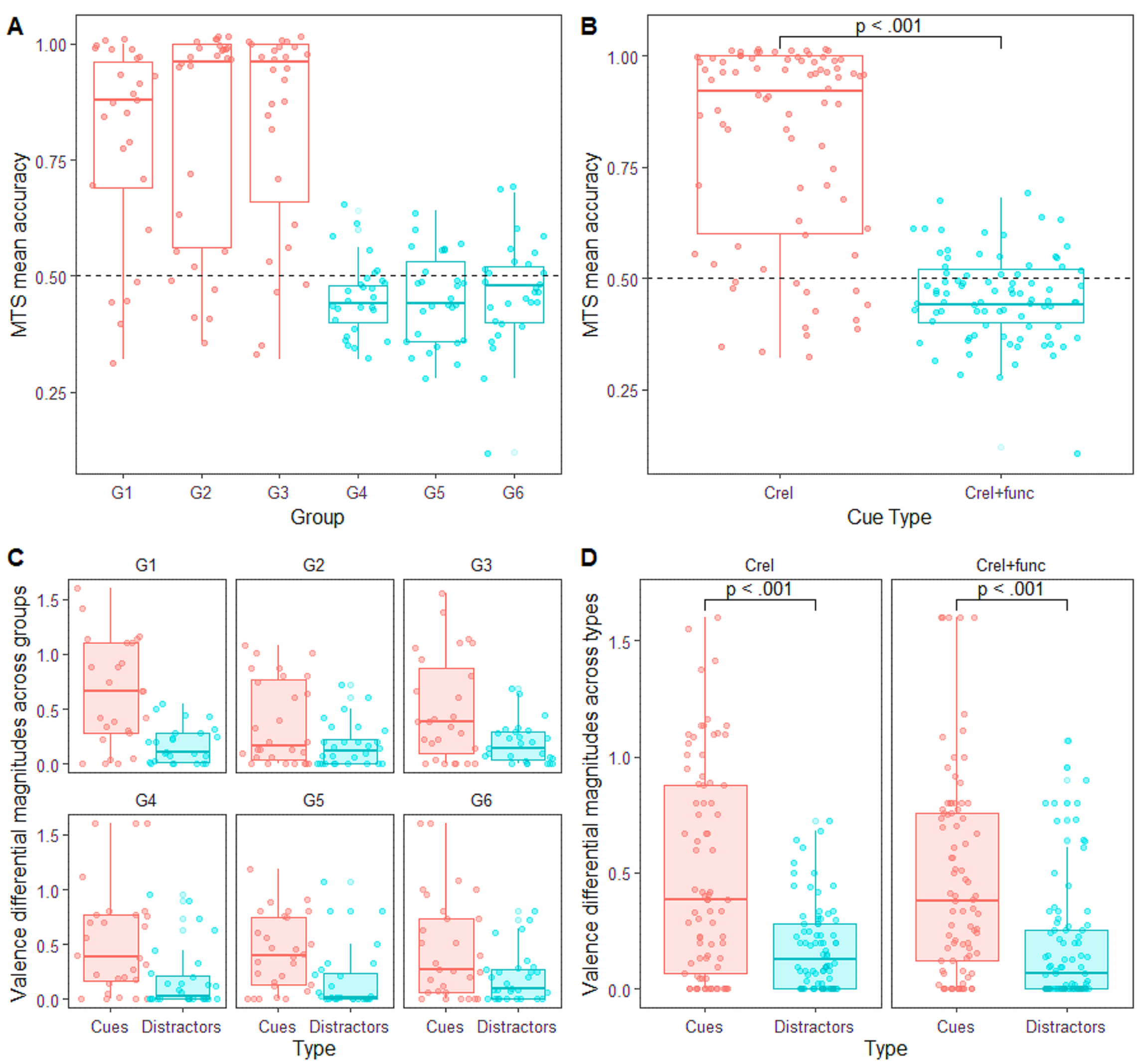

Fig. 2 Summary boxplots of accurate responses produced during MTS test trials (*y*-axes, Panels A and B), as well as Valence Differentials estimated from evaluation trials (*y*-axes, Panels C and D). Individual participant data is represented by horizontally jittered points. During MTS, accurate responses were significantly ($p < .001$) greater across groups who underwent relational (C_{rel}) training relative to groups who underwent relational plus functional ($C_{rel+func}$) training. Analysis of evaluations indicated cues were significantly more differentiated relative to distractors for all groups and across all cue types

A 6 x 2 nested ANOVA, with group (6) nested within cue type (2), did not reveal a significant interaction explaining the variance in MTS performance (p = .76). Only a significant main effect for cue-type was detected, F (1, 160) = 165.42, $p < 0.001$; η^2_p [95% CI] = .51 [0.42,1.00]. A post-hoc Welch's contrast confirmed the mean ± SD accuracy of $n = 81$ participants who underwent C_{rel} training (.77 ± .20) was significantly greater, t (91.22) = 12.68, $p < .001$, d [95% CI] = 1.99 [1.56, 2.41], relative to the n = 85 participants who underwent $C_{rel+func}$ training was (.46 ±.05). A nested model was considered appropriate due to the hierarchical structure of the data, with each group experiencing unique training conditions that were nevertheless "nested" within one of two cue-type categories and predicted to be non-independent (Maxwell et al., 2017).

Valence Differences

All participants evaluated four trigrams before (T1) and after (T2) undergoing MTS. Two were randomly designated as cues (Cue1, Cue2) and the remaining two as distractors (Dis1, Dis2). The latter only appeared during evaluation phases. All evaluations were generated using 9-point visual analog scales, which yielded eight data points per participant. Data was prepared for analysis using the following steps: First, we derived time-normalized difference scores (d = T2-T1/T2+T1) for each cue and distractor independently (Cue_{d1}, Cue_{d2}, Dis_{d1}, Dis_{d2}). Each normalized score represented task-induced evaluative shifts along a standardized scale while controlling for interindividual differences (Amd, 2023a, 2024). Scores smaller (or greater) than 0 indicate a negative (or positive) evaluative shift for said trigram across time. Next, absolute valence differential (VD) estimates were extracted for cues ($Cue_{VD} = |Cue_{d2} - Cue_{d1}|$) and distractors ($Dis_{VD} = |Dis_{d2} - Dis_{d1}|$). Absolute VDs represented the *magnitude* of differences between shifts observed for the two cues/distractors while controlling for individual variability in attribution tendencies (detailed in the Discussion).

Initial data inspection revealed one extreme outlier (Dis_{VD} = 4), motivating that subject's removal from analysis. Among the remaining 165 participants, relatively comparable ranges were observed across Cue_{VD} (min = 0, max = 1.6) and Dis_{VD} (min = 0, max = 1.1) estimates. An exploratory 6 x 2 x 2 ANOVA, with group (6) nested under cue type (2) and trigram type (2), did not produce any significant interactions (all p's > .2). Only a significant main effect of trigram type (Cue vs. Distractors) was found, F (1, 320) = 39.341, $p < .001$; η^2_p [95%] = .11 [0.06,1.00]. A post-hoc Welch's contrast confirmed Cue_{VD} estimates were significantly larger relative to Dis_{VD} estimates, t (319.18) = 6.26, $p < .001$; d [95%] = 0.69 [0.47, 0.91]. Mean (SD) summaries of Cue_{VD} and Dis_{VD} estimates, alongside p-values following [Cue_{VD} - Dis_{VD}] contrasts for individual groups, are provided in Table 3 and Fig. 2 (Panels C and D).

Discussion

In this study, six participant groups (G1–G6) engaged in MTS training and testing aimed at establishing cues specifying comparative relational (C_{rel}) control for groups G1, G2, and G3, or combined relational plus functional ($C_{rel+func}$) control for groups G4, G5, and G6, adopting the methodologies described in Amd and Roche (2015, 2016, 2017). Unlike previous studies that investigated the valences of terms related in the presence of contextual cues, our investigation focused on the valences of the cues themselves. This exploration was theoretically significant as it sought to determine whether relation-specifying (C_{rel}) and function-indicative (C_{func}) properties of contextual cues function as foundational priors or derived posteriors with respect to $C_{rel+func}$ cues that simultaneously exert relational and functional control.

Given that cues categorized as C_{rel} or $C_{rel+func}$ evoked similar evaluative responses, they are operationally non-distinct. Thus, it could be argued that $C_{rel+func}$ control represents an integrated and foundational state of contextual cue properties, with the distinctions between C_{rel} and C_{func} control emerging as derived theoretical distinctions of later abstraction. In addition, because all participant groups were

Table 3 Summaries of Valence Differential (VD) estimates across cues and distractors

Group (Cue-type)	N	*Cue VDs*		*Distractor VDs*		p-value*
		Mean	SD	Mean	SD	
G1 (C_{rel})	26	0.67	0.51	0.32	0.77	0.0289
G2 (C_{rel})	28	0.37	0.38	0.17	0.20	0.0152
G3 (C_{rel})	27	0.50	0.47	0.19	0.19	<u>0.0033</u>
G4 ($C_{rel+func}$)	28	0.53	0.49	0.18	0.29	<u>0.0016</u>
G5 ($C_{rel+func}$)	28	0.43	0.34	0.17	0.29	<u>0.0074</u>
G6 ($C_{rel+func}$)	29	0.46	0.47	0.20	0.23	0.0100

All p-values following [Cue_{VD}-Dis_{VD}] contrasts were statistically significant (all p's < .05). Contrasts significant at a Bonferroni-adjusted threshold (α = .0083) are underlined exposed to training that established cue pairs indicating opposite relational directions (→ vs. ←), the directionality implied by a cue appears to have influenced cue valence. We propose that relational cues indicating opposing relational endpoints (for instance, *more* vs. *less*, *brighter* vs. *darker*, *happier* vs. *unhappier*) can be functionally described as C→ vs. C← cues, respectively. Each symbol "C" represents a distinct $C_{rel+func}$ cue, with the arrows denoting the "relational directionality," which concurrently explains how these cues have differing valences relative to each other.

Before revising RFT, it would be prudent to reproduce these findings with cues specifying opposite directions along other dimensions, such as time (*before* vs. *after*) or space (*above* vs. *below*; *left* vs. *right*). Moreover, if C_{rel} and C_{func} derive from $C_{rel+func}$ control, this reasoning could similarly apply to the notion of $C_{rel+func}$ control (i.e., as a derived instance of some prior "whole"). Hence, the sole theoretical assertion being advanced here is that C_{rel} and C_{func} control are conceptual derivatives of $C_{rel+func}$ control, with the present findings suggesting that C_{rel} and $C_{rel+func}$ cues share a common, prior affective dimension. Assuming affect operates prior to relation-specifying operations ("proposition construction") aligns with former works that suggested affective differentiation precedes derivation/constructive processes during stimulus appraisal (Amd & Baillet, 2019; Amd et al., 2013). This implies that "propositions" may organize around "nonpropositional" (e.g., affective) influences. This diverges from the traditional RFT view, which posits the reverse (i.e., affective C_{func}s organize around relation-specifying C_{rel}s; Mcloughlin et al., 2019).

Previous studies have highlighted how affective and non-propositional processes coincide with, or even supplant, propositional processes (Amd, 2022; Jurchiș et al., 2020). In one representative study, participants trained to derive "happier-than" propositions between images of masked faces, to the effect of *FACE-X is happier than FACE-Y*, evaluated *FACE-X* more favorably relative to *FACE-Y*, aligning with a traditional RFT perspective (Amd & Roche, 2017). However, when *FACE-Y* depicted the participant's masked face, the training to favor *FACE-X* over *FACE-Y* did not alter the innate tendency of participants to "automatically" favor their own face over that of a stranger. This finding that even when contextual control over stimulus relationships can be inferred (e.g., through demonstrating combinatorial entailment), the intended effects of cue-related stimuli will only "transform" propositionally if they were emotionally neutral to begin with. This observation is consistent with previous research indicating that pre-experimentally salient stimuli are inherently resistant to experimental modification, especially in comparison to neutral stimuli (Das, 1969; Staats, 1996; Mowrer, 1980).

To account for the diverse influences of propositional and non-propositional factors, such as affective relations, Amd (2023b) has outlined a "behavioristic epistemology grounded in a direct realist ontology" in service of a common framework for learning theory. This perspective acknowledges propositional ("derived stimulus relations") and non-propositional factors as fundamental to symbolic behavior. We emphasize that "non-propositional" does not imply "mental associations" or any form of "represented content." According to a direct realist ontology, the theoretical relevance of how or whether propositional and non-propositional relations are "mentally represented" is minimal (Amd, 2023b). This focus on ontology distinctly positions Amd's (2022) framework apart from representationalist and social constructionist approaches, setting a robust metaphysical foundation on which a coherent and rigorous scientific inquiry can develop (Amd, 2023b). The broader implications of this standpoint will be explored following a discussion of the current study's limitations.

A criticism could be raised about using a "valence differential" (VD) outcome measure rather than directly reporting evaluations generated for cues and distractors. In response, three statistically attractive properties of the VD estimate can be noted. First, by normalizing scores across time, the VD metric effectively constrains task-induced shifts to a standardized scale (-1 to 1) while mitigating inter-individual variability inherent to raw score comparisons. This normalization allowed assessing how individual trigrams (Cue_{d1}, Cue_{d2}, Dis_{d1}, Dis_{d2}) *shift* in valence over time (Amd & Passarelli, 2020; Amd, 2022, 2023a). Second, computing the absolute difference between normalized cues ($Cue_{VD} = |Cue_{d1} - Cue_{d2}|$) and distractors ($Dis_{VD} = |Dis_{d1} - Dis_{d2}|$) independently highlighted the *magnitude* of the differences between shifts. This approach aligns with the study's objective, which did not hypothesize any specific direction in valence changes across relational cues. By focusing on the magnitude of change rather than its direction, this method also compensated for variability in how individuals ascribe valence. For instance, if half of Group 2 positively evaluated *brighter than* cues whereas the remaining participants negatively evaluated that same cue, maintaining directional information in the VD metric would result in a mean effect approaching the null. This would misleadingly suggest an absence of effect, obscuring the fact that participants had evaluated trigrams differently relative to each other. Finally, focusing on effect magnitudes analytically controlled for feedback-related artifacts, since if feedback had driven cue appraisals, normalized differences across cues would reflect parallel shifts ($Cue_{d1} = Cue_{d2}$), which would result in negligible VDs (if $Cue_{VD} = | Cue_{d2} - Cue_{d1}|$ and $Cue_{d1} = Cue_{d2}$, then $Cue_{VD} = 0$). This pattern was observed across Dis_{VD} scores, suggesting distractor pairs were not differentially evaluated over time. These features justify the analytic decision to transform the raw scores into a single, scaled, and informatively rich VD value.

Another concern involves the observed disparities in MTS performances by participants assigned to C_{rel} versus those assigned to $C_{rel+func}$ conditions (Fig. 2, Panel A). Participants assigned to C_{rel} conditions (Groups G1, G2, G3) generated significantly more accurate responses during MTS test trials than those assigned to $C_{rel+func}$ conditions (Groups G4, G5, G6). This suggests that the former participants had accurately recognized and attributed the intended relational functions (e.g., Cue1 represents *more-than* in G1). At the same time, those in the $C_{rel+func}$ conditions might have mistakenly associated reinforcement contingencies with irrelevant structural features of the task (Jones et al., 2009). Unlike dots or squares, emotional faces can directly elicit evaluative responses based on their expressions (happy, calm, unhappy, excited), regardless of relational context. It is possible that these structural features influenced participants allocated to Groups G4 to G6 to rely on identity-based discriminations (e.g., choosing the smiling face or the face with an open mouth) rather than making comparative judgments that aligned with the study's objectives (e.g., selecting the "happier" face in the presence of a *happier-than* cue). Although both approaches reflect $C_{rel+func}$ control in principle, the research design intended only comparative (e.g., *happier-than*) discriminations. Thus, the conditional discrimination of, for example, a happy face from a happy/sad pair in the presence of a *happier-than* cue could have been due to cue-specified comparative discriminations (e.g., select the "happier" face), *or* motivated by the comparison's constitutive features (e.g., mouth curvature).

One possibility is that participants assigned to the $C_{rel+func}$ conditions might have been more/less susceptible to interfering contingencies due to differences in complexity of comparison features. Recall that participants across C_{rel} conditions were tasked with discriminating among minimally featured comparisons (dots and squares). This provided fewer opportunities for stimulus countercontrol by extraneous surface features (McIlvane & Dube, 2003). In contrast, $C_{rel+func}$ comparisons comprised of human faces, which presented higher visual complexity and increased potential for feature-driven countercontrol. Although our study aimed to limit such confounds by varying only the expressions across faces, this measure might not have eliminated feature-based biases. Similar concerns were raised by Amd and Roche (2015, 2016, 2017) to justify their deployment of masked/cartoon face comparisons when establishing $C_{rel+func}$ cues with MTS, as the former reduced surface complexity and potential for countercontrol relative to natural faces. Those studies demonstrated that *happier than* and *unhappier than* $C_{rel+func}$ cues could be reliably established once extraneous facial features were controlled. On balance, the extent to which responses to artificially processed (e.g., masked) faces generalize to real-world scenarios is unknown. This consideration partly motivated the decision to deploy unprocessed faces currently, which concurrently increased the possibility for feature-based countercontrol. Future research could explore artificially processed faces to determine if this influences the establishment of relational cues, as informed by MTS accuracy rates.

Another concern is that relational (C_{rel}) cues may not have been effectively established across Groups G1 and G2, perhaps due to "insufficient" multiple exemplar exposures (Hayes et al., 2001). For instance, G1 participants, who were presented with comparison pairs varying in dot numbers, may have perceived the cues as indicative of quantitative differences along a particular physical dimension (e.g. *more dots than* and *fewer dots than*) rather than abstracting the intended C_{rel}s of *more-than* and *less-than*. Likewise, G2 participants could have appraised cues in terms of their concrete differences (*brighter grey square* and *darker grey square*) rather than the abstracted C_{rel}s of *brighter-than* and *darker-than*. In sum, it is possible that (some) participants had interpreted cues in both scenarios as specifying combined relational and functional control (e.g., *brighter grey square*) instead of purely relational (e.g., *brighter-than*) control. In both cases, G1 and G2 participants would have abstracted cues exerting $C_{rel+func}$ (e.g. *brighter grey square*) instead of C_{rel} (*brighter-than*) control.

Four points can be raised in response. First, the notion of a "sufficient" number of multiple exemplar exposures for establishing a C_{rel} (versus C_{func} or $C_{rel+func}$) cue is ill-defined. The parameters for such a distinction are ambiguous, lacking any consensus on their a priori determination or applicability across different stimuli and contexts. Second, it is only through recognizing the targeted relational dimensions (quantity for G1 and luminosity for G2) that dots and squares could be categorized in relational terms. For example, a square's brightness or darkness is always in relation to another square in a visual environment where extraneous variables are controlled. Within a traditional RFT framework that asserts C_{rel} and C_{func} separability, the differentiation of "brighter/darker" gradients *is* the expression of C_{rel} control. Third, assuming cues exerted $C_{rel+func}$ (*more dots than*) instead of a more general C_{rel} (*more than*) control leaves the common C_{func} as one of "some dots." It is difficult to see how indiscriminate quantities of black dots on a white background (G1), a grey square (G2), or either (G3) could elicit differential evaluative responding unless cue-specified relational "directionality" (C→ and C←) is taken into consideration.

Finally, the concept of C_{rel} control describes a contextual cue's "relating" properties, but "relating" cannot function in situ. Specifying relations presupposes terms and some overlapping psychological dimension(s), meaning any contextual cue would be $C_{rel+func}$ "to start with." The concept of C_{rel} control might well be abstracted following extended multiple exemplar training with such cues, but this only means the former is a posterior abstraction of a more complex $C_{rel+func}$ category. Further, just as C_{rel} and C_{func} are posterior abstractions of a $C_{rel+func}$ "whole," the latter may too be a contrived abstraction of some yet-undefined "whole," which future works can assess.

The possibility that cues trained to exert purely relational (C_{rel}) control may have gained affective functional characteristics (C_{func}s) might also have been influenced during stimulus evaluation phases that had used visual analog scales (VASs). Adapted from Amd et al. (2019), these scales involved participants adjusting a slider between happy and sad cartoon faces as an indicator of positive or negative valence. It is conceivable that some relational cue, such as *brighter-than*, alongside these cartoon faces consequated the unintended derivation of "some" relation between the cue and a face, influenced by preexisting expectations of how such cues and faces "ought" to be related. This is further complicated by the socialized connotations attached to relational terms in natural language (e.g., the contrast between being described as "bright" vs. "dim").

The likelihood that prior, task-unrelated beliefs can influence evaluative responses generated in the lab is enhanced when when participants have the opportunity to deliberate and revise their responses before submitting, as under unconstrained operating conditions (Amd, 2024; Passarelli et al., 2020). Because all participants had the chance to reflect and adjust their evaluations before finalizing their responses, it is possible that some participants adopted irrelevant strategies for their evaluations. To counter this possibility, future works may consider including a "pass" or "I do not know" response option during the evaluation phases. On balance, "forcing" cue evaluations can inflate the possibility of Type 1 error (depicting cues as valenced even if they are not experienced as such), though a potential benefit is the revelation of cue-valence mappings that are marginally more likely (e.g., *more-positive* mappings being more frequent than *more-negative* mappings). Furthermore, a "pass" or "I do not know" option would minimize effort requirements from participants, potentially leading to a rise in Type 2 errors as participants may opt for "pass" (as it is the least effortful response) even when confronted with a cue that has evaluative significance.

One might question why participants were not asked to report their evaluation strategies on a trial-by-trial basis. Such an approach would directly ascertain the relational and affective attributes participants derived concerning the cues. Implementing trial-by-trial strategy assessments, similar to the methodology used by Jurchiș et al. (2020), could illuminate whether participants' strategies align with the relation targeted by the experimenter by highlighting sources of C_{rel} and C_{func} control. Suppose cues can be shown to exert C_{rel} control without the participants' conscious recognition of cue functions. In that case, C_{rel} control can be asserted as preceding $C_{rel+func}$ control, aligning with the relational frame theory's distinction between C_{rel} and C_{func} controls. On the other hand, should contextual relational control only be observable with an awareness of functional dimensions, it would follow that C_{rel} and C_{func} control are practically inseparable, and likely contingent on prior $C_{rel+func}$ control.

The decision to forego soliciting cue reports in this study was deliberate and informed by four considerations. First, requesting participants to describe the meaning of cues on a trial-by-trial basis might have risked orienting participants' attention to nonessential stimulus features and induced task-unrelated demand effects (Amd, 2022; Corneille & Lush, 2023). Second, had an end-of-task knowledge check been applied, reported outcomes would be confounded by recency artefacts, as strategies for the most recently evaluated cue would be the most prominent in memory (Shanks & St. John, 1994). Third, given the varied and personal nature of individuals' experiences with language, asking participants to articulate what cues "meant" could tether evaluations to some unique aspect of participants' "verbal history (rather) than (any) effects of current experimental operations" (Sidman, 1992, pp. 21–22). Finally, the possibility of salient, task-unrelated propositions ("prior beliefs") influencing participant evaluations, particularly under unconstrained responding conditions, is unavoidable (Amd & Baillet, 2019; Amd, 2023b). When participants can freely deliberate before responding, the impact of prior beliefs on emitted responses is an ever-present possibility (Amd, 2024). These considerations collectively contributed to the design decision of foregoing trial-by-trial verbal reports, though future extensions are encouraged to consider their incorporation.

Other RFT research has raised the issue of prior meanings influencing the appraisal of relational cues. For instance, the *Differential Arbitrarily Applicable Relational Responding* (DAARRE) model, introduced by Finn et al. (2018), addresses why certain trial types in the IRAP (implicit relational assessment procedure) tend to systematically deviate from responses generated across other trial types across administrations. According to DAARRE, some response options (e.g., "True") are more likely to cohere with positive valences than other response options ("False"), translating to observed variations across output parameters. Applied to the present study, a DAARRE interpretation might suggest that the established C_{rel}s of, say, *more-than* or *brighter-than* would be already positively valenced relative to *less-than* or *darker-than* respectively. Although compatible with the current findings, this interpretation reveals several complications upon closer inspection. First, by predicting valence directionality (i.e., *brighter* should be more positive than *darker*), all observations to the contrary (e.g., participants who evaluated *darker-than* more positively than *brighter-than*; see Fig. 2) invalidates DAARRE's prescriptive utility without ad hoc adjustments. Second, DAARRE presupposes the separability of C_{rel} and C_{func} control to render inferences about their "relational coherence", but the present findings suggest cues operate as $C_{rel+func}$ by default. As a result, claims about "relational coherence" between abstracted C_{rel} and C_{func} components become irrelevant.

The present study demonstrated the affective differentiation of relational cues denoting opposite directions (C→, C←) along a shared functional dimension, underscoring a novel insight into the operations of contextual cues during symbolic learning. Although it's important to approach generalizations based on a single investigation cautiously, the implications of these findings for understanding relational cues in symbolic learning merit consideration. One insight is that cues indicating opposing directions are not affectively interchangeable (C→ ≠ C←), suggesting that symbolic relations deemed functionally equivalent may contain cues with distinct affective connotations. To illustrate, consider the pair of "functionally equivalent" propositions: *John is happier than Bob* [P1], and *Bob is unhappier than John* [P2]. Assuming both *John* and *Bob* were initially affectively neutral (*John* = *Bob*), the logical inference following P1/P2 would be a favorable evaluation of *John* relative to *Bob*, affirming the functional equivalence of P1 and P2. Yet, the relational cues embedded across P1 and P2 are not equivalent (*happier* ≠ *unhappier*), which may produce evaluative effects downstream during the stimulus–response processing chain. This distinction highlights a subtle albeit significant aspect of how relational cues might operate, showing that even when cue-specified relations share functional equivalency, the emotional connotations evoked may diverge based on the "relational directions" of the cues employed.

To test this hypothesis, a future extension could record cue valences and utilize them for establishing relationally equivalent statements (e.g., propositions P1 and P2) and explore for any variance in "transformation of function" (TOF) effects. The present findings raise the possibility that the valences of relation-specifying cues may extend to the terms they connect, affecting the perceived magnitude of differences between them. For instance, if *more-than* (>) and *less-than* (<) cues are deployed exclusively to form a pair of functionally equivalent comparative networks [A > B > C] and [C < B < A], traditional RFT would predict similar outcomes (A > C) following either sequence (Amd & Roche, 2015). However, should the directionality of the relation effect cue valence and subsequently generalize to the terms linked in their presence, it is feasible that TOF effect magnitudes might vary between networks. Thus, although both [A > B > C] and [C < B < A] networks can produce [A > C] effects, the intensity of these TOFs between A and C may differ due to valences generalizing from the cues to the terms (Amd, 2022). This prospective study would elucidate whether the emotive attributes associated with cues extend to the terms they relate. In addition, it is necessary to replicate the reported effects in the presence of other relational types (e.g., *before* vs. *after*, or *above* vs. *below*) before confirming the breadth of these effects. The remainder of the discussion speculates on the theoretical and practical ramifications of the claims made presently.

The present research was aligned with a realist approach to learning theory, which emphasizes the plurality of affective, organizational, and propositional relations in the conduct of symbolic behavior (Amd, 2022, 2023a). This perspective opens the door to investigating socially significant behaviors through a lens that appreciates the depth of psychological processes beyond mere language-based processes. In a representative study on "colorist" attitudes, for example, Amd (2024) illustrated how skin tone can bias the perception of attractiveness and opposite-sex faces when propositional moderation is constrained, underscoring the influence of preverbal and non-propositional factors in shaping behaviors traditionally attributed to language processes. Acknowledging the significance of propositional and non-propositional influences on behavior significantly broadens the analytical scope of psychological experiences associated with socially pertinent behaviors.

The acknowledgment of non-propositional influences not only enriches theoretical understanding but also has practical implications, including for therapeutic interventions. By prioritizing intuitive and affective responses, therapists can try to integrate novel approaches directly targeting non-propositional relations to complement traditional talk therapy. A series of studies by Amd and colleagues (Amd, 2023b; Amd & Passarelli, 2020; Passarelli et al., 2020; Amd & Baillet, 2019) have demonstrated the potential of "subliminal" conditioning to influence affective and motivational states without necessitating mediation by conscious propositional thought, thereby sidestepping biases entrenched in conscious awareness. In another study, Amd (2023a) reported how the non-conscious appraisal of positive self-evaluative statements can enhance mood in ways that conscious appraisal does not, suggesting that conscious processing might activate counteractive beliefs latent in conscious awareness (e.g., rebutting a positive statement with a negative, previously held belief about oneself). Subliminal conditioning offers one promising avenue for therapists wishing to bypass belief systems that are resistant to change through conventional methods by leveraging nonpropositional processes.

Beyond therapy, educational practices could also benefit from incorporating activities that emphasize non-propositional knowledge sources, such as experiences acquired through nature expeditions. mountain climbing or authentic participation in religious rituals. These approaches, deeply rooted in the cultures they originate, encapsulate an intuitive understanding and knowledge base that is difficult to translate within contemporary proposition-centered approaches to education (Guénon, 2004).

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Author Contribution Micah Amd conceived and designed the study, performed the experiments, analyzed the data, prepared all figures and tables, and wrote the manuscript. The author thanks Denise Passarelli for assistance with data collection.

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Data Availability Data and the script for replicating reported analyses are freely accessible on OSF at https://osf.io/6gszw/?view_only=f358a6c94d494bf880dd5f41717c285f.

Declarations

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