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# Dissociating preferences from evaluations following subliminal conditioning☆

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ABSTRACT

Preferences towards unfamiliar drink brands may be influenced through subliminal conditioning. This can involve associating unfamiliar brands (CS) with positively valenced attributes (US) under constrained visual conditions to prevent the former's conscious detection. According to learning theory, CS associated with positive US should become increasingly preferred as the latter's positive valences generalizes (transfer) across associated CS. Similarly, correlating CS with negative US should reduce CS-associated preferences. There is some evidence that CS-associated preferences can be reliably influenced through subliminal conditioning (Elgendi et al., 2018). Conversely, there is also evidence that subliminal conditioning does not effectively alter evaluations of CS valence (Heycke et al., 2018). Those works suggest CS preferences may be more susceptible to subliminal valence transfer relative to CS evaluations. We explored this hypothesis presently, where four pairs of supraliminal/visible and subliminal trigrams (CS) were respectively associated with four US categories varied along aggregate valence (100% positive, 80% positive, 20% positive, 0% positive). CS evaluations and preferences were recorded before and after conditioning. Bayesian analyses revealed US valence manipulations were likely to shift preferences, but not evaluations, of subliminal CS. Across supraliminal CS, Bayesian and frequentist analyses indicated US valence was significant and likely to shift preferences and evaluations. The present study demonstrates preferences may be influenced through subliminal conditioning even as evaluations are not.

## 1. Introduction

Presenting thirsty individuals with drink-associated concepts can influence preferences across said drinks (Karremans, Stroebe, & Claus, 2006; Strahan, Spencer, & Zanna, 2002). For example, presenting the word *Coke* may cause a thirsty individual to consistently select Coca-Cola from a range of available drinks without being consciously aware of deliberately doing so (Smarandescu & Shimp, 2015, Study 1). When presenting concepts/symbols[1] influences associated (motivational) responses, as when presenting brand-labels influence subsequent preferences between brands, those symbols are considered *primes* (Elgendi et al., 2018). When primes appear under constrained visual conditions to minimize their "conscious detection (p. 2)", they are *subliminal*. Subliminal priming effectiveness vis-à-vis augmenting associated motivational states may be enhanced through *subliminal conditioning*, which involves "priming (a) behavioral concept and linking it to positive affect" (Veltkamp, Custers, & Aarts, 2011, p. 49). In learning theory, symbols that become emotionally salient following systematic associations with affective attributes are described as Conditional (CS) and Unconditional (US) stimuli respectively (Mowrer, 1980; Staats & Staats, 1958; Tonneau & González, 2004). The emerging congruence between the valence of a CS with associated US can be described as US-to-CS valence transfer/transformation (Amd, de Oliveira, Passarelli, Balog, & de Rose, 2018; Tonneau & González, 2004). The recognition of CS valence transfer as a symbolic effect following CS-US pairings have also been recognized by theorists from constructivist perspectives (e.g., De Houwer, 2007).

Subliminal conditioning has shown some success in priming

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[1] We use 'symbols' in their semiotic sense, which refers to *any* sign interpretable through socio-cultural convention, not only words (Peirce, 1992).

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drinking behavior (Veltkamp et al., 2011), preferences between drink brands (Karremans et al., 2006) and saliva production (Amd & Baillet, 2019). Across those studies, CS associated with eating and drinking activities had been associated with positively valenced US, predictably augmenting response components associated with eating (e.g., saliva production) and drinking (e.g., brand preference). Yet, other researchers have reported that CS which have to be deliberately *evaluated* along valence following some subliminal CS-US conditioning procedure are less likely to track the valences of any associated US (Greenwald & De Houwer, 2017; Heycke & Stahl, 2018).

On one hand, subliminal CS associated with positive US stop being evaluated in accordance with the latter's valence at predictable levels when appearing for latencies of 42 ms or less (Greenwald & De Houwer, 2017, Series 1). On the other hand, CS-associated motivational responses *are* predictably influenced following associations of subliminal CS with positive US, even when the former appear for briefer durations (17–33 ms; Elgendi et al., 2018). Subliminally conditioned primes (CS) may thus influence motivational states even as evaluations towards the same CS remain unaffected.

### 1.1. Disassociating motivation from evaluation

The claim that positive US-to-CS valence transfer can influence CS-associated motivational states, but not CS evaluations, was suggested recently by Amd and Baillet (2019). In that study, CS and US consisted of eating-related verbs and positive/neutral attributes respectively. During conditioning, CS appeared for 17 ± 1 and 160 milliseconds (ms) respectively, with the former sandwiched between masks of > 100 ms durations. Conditioning influence on appetite motivation was assessed with three measures: first, participants responded *Yes/No* within a restricted time window to the question *Are you getting hungry?* following individual conditioning trials. Second, salivary volume was assessed before and after each trial block. Finally, participants orally reported their desire to engage in various activities, including *running*, *sleeping*, *reading*, and *eating*. Analyses revealed saliva production and proportions of *Yes* responses (to the question *Are you getting hungry*) had significantly increased after/as eating-related CS were associated with positive US. Conversely, orally reported preferences towards *eating* remained statistically unaffected by US valence (for a similar finding with visible/supraliminal CS, see Jansen, Boon, Nauta, & Van den Hout, 1992). Assuming saliva production and time-restricted forced choices reflect the operation of automatic/pre-verbal bottom-up influence over directed, top-down evaluations, Amd and Baillet's (2019) work illustrated response components associated with appetite motivation had been manipulated via subliminal conditioning, even as orally reported preferences remained unaffected.

Two limitations from that study need mention. First, participants had orally declared activity *preferences*, which may not correlate with activity *evaluations*. That is, we do not know whether CS valences would have been evaluated differently even as self-reported hunger appeared unaffected. Second, presenting exclusively positive and neutral US across separate trial blocks means that the effects reported by Amd and Baillet may have been produced through indirect valence generalization rather than direct US-to-CS valence transfer (Amd et al., 2018; Tonneau & González, 2004). We addressed the limitations of Amd and Baillet's (2019) investigation here. We expand on that work by asking whether can preferences and valence evaluations are similarly susceptible to valence transfer following subliminal conditioning. A null difference would imply both performances incorporate integrative process chains during expression. Alternatively, asymmetrical effects between evaluation and preference measurements would suggest distinct processing chains are involved.

### 1.2. The present study

We determined the influence of CS-US conditioning on CS evaluations and CS preferences currently. Evaluations and preferences were collected before and after conditioning, with the resultant mean differences (*d-scores*) analyzed to indicate influence of conditioning. Two features of our design stand out relative to earlier works in this area: first, valenced attributes (US) were associated with pairs of subliminal *and* supraliminal trigrams (CS) concurrently during conditioning. Since supraliminal CS are more likely to cohere with US valence when both are consciously detected during CS-US associations ceteris paribus (Das, 1969/2014; Greenwald & De Houwer, 2017; Sweldens, Corneille, & Yzerbyt, 2014), supraliminal CS is predicted to reliably track US valence. By linking US with supraliminal and subliminal CS concurrently, we could directly answer whether US valence manipulations become less effective towards manipulating CS valence when the latter is subliminal, as suggested in recent works (Greenwald & De Houwer, 2017; Heycke & Stahl, 2018). A second distinguishing feature of our study was the use of four US categories incrementally varied along aggregate valence (from positive to negative) but matched along arousal/intensity. The four categories were labelled *allPos, mostPos, mostNeg* and *allNeg* (see Materials). Varyingly valenced US categories allowed us to determine whether evaluations/preferences are more likely to incorporate integrative or summative processes. Regarding the former, CS evaluations may result from the temporal integration of context-specified inferences (e.g., Aust, Haaf, & Stahl, 2019), which would produce no significant variation across CS associated with *allPos* and *mostPos* (*allPos* ~ *mostPos*), or across CS associated with *allNeg* and *mostNeg* (*allNeg* ~ *mostNeg*) as both inferences involve temporal integrations across congruent valence categories. On the other hand, CS valences may incrementally update based on the summative valence of associated US categories. Evidence for summative valence transfer would be revealed across one-sided (*allPos* vs *mostPos*) and (*mostNeg* vs *allNeg*) differences.

## 2. Method

### 2.1. Participants

90 participants were recruited from the undergraduate student population at the Federal University of São Carlos (UFSCar) through online invitation. The data of six participants were lost/discarded due to programming and data collection errors, leaving a final sample of $n = 84$ ($M = 21.4$, $SD = 2.2$ years, 37 females). None of our recruits reported confounding medical or psychiatric histories prior to participating. Participants were offered coffee and vegan chocolates, or the equivalent value in cash (BRL$10), following task completion. Participants took around 20 min to complete the present task. All procedures reported here were approved by the UFSCAR committee for ethical research and corresponds with the guidelines outlined in the Helsinki declaration.

### 2.2. Materials

Trigrams designated to be CS were ZAF, NUV, XAB, KUJ, RYV, NYD, HIX and ZIQ. CS assignment was blindly varied between participants. Meaningless trigrams were assigned to be CS as they are less salient than familiar words and more susceptible to US valence manipulations (e.g. Cacioppo, Marshall-Goodell, Tassinary, & Petty, 1992). All CS were of similar length, appeared equal numbers of times across the conditioning task, and all were presented in a black 18 Arial font against white enclosed backgrounds. CS were sandwiched by masks of equal character length (consisting of the characters '###'), presented in a similar font against a white background. In sum, our setup controlled for prime-background contrast, mask structure, mask/CS durations, mask/CS lengths, presentation frequency, character size and CS salience. US were selected from a list of 80 positive and 80 negative attributes adopted from Kristensen, Gomes, Justo, and Vieira' (2011) dataset of Brazilian Affective Norms (Table 1). Selection criteria

**Table 1**
Positive and Negative attributes adapted from Kristensen et al. (2011).

| Positive terms | Valence | | Arousal | | Negative terms | Valence | | Arousal | |
|---|---|---|---|---|---|---|---|---|---|
| | M | *SD* | M | *SD* | | M | *SD* | M | *SD* |
| CARÍCIA | 8.8 | 0.6 | 4.4 | 3.7 | INFERNO | 3.8 | 2.9 | 4.9 | 3.1 |
| AMOR | 8.8 | 0.9 | 4.4 | 3.5 | HEMODIÁLISE | 3.8 | 2.4 | 4.9 | 2.9 |
| CARINHOSO | 8.7 | 0.8 | 4.4 | 3.0 | ESCORBUTO | 3.8 | 1.9 | 4.0 | 2.6 |
| FELIZ | 8.7 | 1.0 | 4.1 | 3.7 | MOTIM | 3.8 | 2.3 | 4.4 | 2.9 |
| ABRAÇAR | 8.6 | 1.2 | 4.3 | 3.2 | LENTO | 3.8 | 2.1 | 4.7 | 3.0 |
| ALEGRIA | 8.6 | 1.5 | 4.9 | 3.6 | CARCAÇA | 3.8 | 2.2 | 4.3 | 2.7 |
| RISADA | 8.6 | 0.9 | 4.6 | 3.5 | DESERTOR | 3.7 | 1.6 | 4.6 | 2.2 |
| SORRISO | 8.5 | 1.3 | 4.2 | 3.2 | ULTRAJE | 3.7 | 1.8 | 4.2 | 2.4 |
| ALEGRE | 8.4 | 1.1 | 4.0 | 3.5 | BELISCAR | 3.7 | 2.4 | 4.8 | 2.7 |
| CAMPEÃO | 8.4 | 1.2 | 5.0 | 3.4 | PREGUIÇOSO | 3.7 | 2.3 | 4.1 | 2.7 |
| OTIMISMO | 8.4 | 1.3 | 4.1 | 3.6 | VESPA | 3.6 | 2.2 | 4.5 | 3.1 |
| SAÚDE | 8.4 | 1.3 | 4.1 | 3.5 | INSOSSO | 3.6 | 1.9 | 4.2 | 2.6 |
| COMÉDIA | 8.4 | 1.3 | 4.4 | 3.5 | VAMPIRO | 3.6 | 2.1 | 4.4 | 2.9 |
| ANIVERSÁRIO | 8.4 | 1.2 | 4.7 | 3.3 | ESTAGNADO | 3.5 | 2.0 | 4.9 | 2.3 |
| QUERIDO | 8.4 | 1.2 | 4.0 | 3.6 | ESCORPIÃO | 3.5 | 2.1 | 4.6 | 2.9 |
| PIZZA | 8.4 | 1.2 | 4.2 | 3.4 | DESPERDÍCIO | 3.5 | 1.9 | 5.0 | 2.5 |
| ROMÂNTICO | 8.3 | 1.4 | 4.2 | 5.4 | PECAMINOSO | 3.4 | 2.1 | 4.7 | 2.7 |
| VIVO | 8.3 | 1.5 | 4.7 | 3.5 | BASTARDO | 3.4 | 2.5 | 4.2 | 2.7 |
| ANIMAÇÃO | 8.3 | 1.4 | 4.6 | 3.0 | PESAR | 3.4 | 2.4 | 4.8 | 2.6 |
| PRESENTE | 8.3 | 1.3 | 4.8 | 3.4 | PERVERTIDO | 3.4 | 2.3 | 5.1 | 2.7 |
| NASCIMENTO | 8.3 | 1.2 | 4.3 | 3.1 | CORTE | 3.3 | 1.8 | 5.1 | 2.7 |
| TALENTO | 8.3 | 1.2 | 5.0 | 3.4 | PECADO | 3.3 | 2.1 | 4.2 | 2.8 |
| QUALIDADE | 8.3 | 1.4 | 4.6 | 3.4 | PÚTRIDO | 3.3 | 2.1 | 4.2 | 2.6 |
| PRAIA | 8.3 | 1.4 | 4.6 | 3.5 | PEDINTE | 3.2 | 2.1 | 4.9 | 2.6 |
| ESPERANÇA | 8.3 | 1.4 | 5.0 | 3.5 | APÁTICO | 3.2 | 2.0 | 4.9 | 2.7 |
| CONHECIMENTO | 8.3 | 1.3 | 5.1 | 3.0 | FEITO | 3.2 | 2.3 | 4.2 | 2.6 |
| SOL | 8.3 | 1.7 | 4.3 | 3.1 | DEFICIENTE | 3.1 | 1.9 | 4.1 | 2.9 |
| DIVERTIMENTO | 8.3 | 1.6 | 4.9 | 3.3 | INSANO | 3.1 | 2.0 | 4.6 | 2.5 |
| CINEMA | 8.3 | 1.4 | 4.8 | 3.0 | ENCARDIDO | 3.1 | 1.6 | 4.0 | 2.5 |
| ADORÁVEL | 8.2 | 1.6 | 4.0 | 2.9 | LARVA | 3.1 | 1.9 | 4.3 | 2.8 |
| SABOROSO | 8.2 | 1.4 | 4.1 | 3.0 | DESDENHOSO | 3.0 | 1.8 | 4.9 | 2.5 |
| FESTA | 8.2 | 1.6 | 4.5 | 2.7 | CUPIM | 3.0 | 1.9 | 4.6 | 3.0 |
| ATRAÇÃO | 8.2 | 1.5 | 4.8 | 3.2 | ESPINHO | 3.0 | 1.7 | 4.5 | 2.9 |
| MELHORAR | 8.2 | 1.6 | 4.6 | 3.3 | BURRO | 3.0 | 1.9 | 4.7 | 2.7 |
| APLAUSO | 8.2 | 1.2 | 5.0 | 2.7 | LODO | 2.9 | 2.2 | 4.4 | 2.6 |
| PERFUME | 8.2 | 1.2 | 4.3 | 3.3 | SÓRDIDO | 2.9 | 2.1 | 4.6 | 2.6 |
| GLÓRIA | 8.2 | 1.6 | 4.7 | 3.3 | AZEDO | 2.9 | 2.0 | 4.4 | 2.1 |
| PIADA | 8.1 | 1.3 | 4.5 | 3.2 | ATADURA | 2.9 | 2.3 | 4.5 | 2.9 |
| TRIUNFANTE | 8.1 | 1.4 | 5.0 | 3.3 | ÓDIO | 2.9 | 2.2 | 4.8 | 3.1 |
| SALVAR | 8.1 | 1.4 | 4.6 | 2.9 | RESSENTIDO | 2.8 | 1.9 | 4.8 | 2.2 |
| RADIANTE | 8.1 | 1.6 | 4.7 | 3.3 | MULETA | 2.8 | 1.9 | 4.8 | 2.8 |
| CHOCOLATE | 8.1 | 1.4 | 4.9 | 3.3 | NARCÓTICO | 2.8 | 2.0 | 4.9 | 2.9 |
| TROFÉU | 8.0 | 1.7 | 4.7 | 3.2 | PUS | 2.7 | 1.9 | 4.8 | 2.7 |
| EDUCAÇÃO | 8.0 | 1.8 | 4.9 | 3.2 | TOLO | 2.7 | 1.6 | 4.4 | 2.6 |
| CONFORTO | 8.0 | 1.5 | 4.2 | 3.3 | PULGA | 2.7 | 2.0 | 4.3 | 3.1 |
| ENTUSIASMO | 8.0 | 1.8 | 4.8 | 3.1 | REPUGNADO | 2.7 | 1.8 | 4.6 | 2.3 |
| IMAGINAR | 8.0 | 1.7 | 5.1 | 3.0 | DIABO | 2.7 | 2.2 | 4.6 | 2.9 |
| PAQUERAR | 8.0 | 1.5 | 4.5 | 3.3 | GANGRENA | 2.6 | 2.1 | 4.8 | 2.8 |
| CONFIANÇA | 8.0 | 2.1 | 4.7 | 3.3 | NAVALHA | 2.6 | 1.8 | 5.0 | 3.2 |
| LUZ | 8.0 | 1.6 | 4.3 | 3.2 | ENJOATIVO | 2.6 | 1.5 | 4.7 | 2.5 |
| NOVO | 8.0 | 1.3 | 4.9 | 3.0 | RIDÍCULO | 2.6 | 1.9 | 4.9 | 2.7 |
| CARRO | 8.0 | 1.8 | 4.4 | 3.6 | CAVEIRA | 2.6 | 1.8 | 5.1 | 2.8 |
| MILAGRE | 8.0 | 1.7 | 5.0 | 3.2 | PROSTITUTA | 2.6 | 2.0 | 4.6 | 3.0 |
| TRIUNFO | 7.9 | 1.5 | 4.6 | 3.3 | FERIMENTO | 2.5 | 1.8 | 5.1 | 2.6 |
| CRIANÇA | 7.9 | 1.8 | 4.1 | 3.1 | DESTROÇAR | 2.5 | 1.8 | 4.4 | 3.0 |
| ORGASMO | 7.9 | 1.7 | 4.4 | 2.9 | SARAMPO | 2.5 | 1.6 | 4.5 | 2.7 |
| PROGRESSO | 7.9 | 1.9 | 4.8 | 2.7 | INFERIOR | 2.5 | 1.9 | 4.5 | 2.7 |
| PROMOÇÃO | 7.9 | 1.9 | 4.9 | 3.4 | MOFO | 2.5 | 2.0 | 4.6 | 2.9 |
| DOCE | 7.9 | 1.8 | 4.5 | 2.7 | DESAMPARADO | 2.5 | 1.7 | 5.0 | 2.6 |
| APRENDER | 7.9 | 1.8 | 4.8 | 3.2 | SOZINHO | 2.5 | 2.0 | 5.0 | 3.0 |
| PESSOA | 7.9 | 1.6 | 4.5 | 3.1 | FLÁCIDO | 2.4 | 2.0 | 4.8 | 2.9 |
| CASAL | 7.8 | 1.9 | 4.1 | 3.2 | FRÍGIDA | 2.4 | 2.1 | 4.8 | 2.8 |
| RÁDIO | 7.8 | 1.7 | 4.1 | 2.9 | DEFORMADO | 2.4 | 1.8 | 5.0 | 2.9 |
| CURAR | 7.8 | 1.7 | 4.4 | 3.3 | CEGO | 2.4 | 1.9 | 4.7 | 2.7 |
| EXCURSÃO | 7.8 | 2.0 | 4.9 | 3.2 | DANO | 2.3 | 1.8 | 4.7 | 2.7 |
| INTELIGENTE | 7.8 | 2.3 | 4.8 | 3.3 | VÔMITO | 2.3 | 1.5 | 4.5 | 2.5 |
| PRÓSPERO | 7.8 | 1.9 | 4.4 | 3.0 | DETESTAR | 2.3 | 1.7 | 4.4 | 3.1 |
| DESEJO | 7.8 | 1.7 | 5.1 | 2.9 | FEBRE | 2.2 | 1.7 | 4.9 | 2.9 |
| TERRA | 7.8 | 1.9 | 4.1 | 3.3 | MALÁRIA | 2.1 | 1.6 | 5.0 | 3.2 |
| JÓIA | 7.8 | 1.8 | 4.2 | 3.4 | DEMÔNIO | 2.1 | 1.7 | 4.5 | 3.3 |
| PRESTÍGIO | 7.8 | 2.0 | 4.3 | 3.0 | PIOLHO | 2.1 | 1.5 | 5.1 | 3.2 |
| MACIO | 7.7 | 1.8 | 4.1 | 3.3 | IMORAL | 2.0 | 1.6 | 5.0 | 3.0 |

(*continued on next page*)

**Table 1** (*continued*)

| Positive terms | Valence | | Arousal | | Negative terms | Valence | | Arousal | |
|---|---|---|---|---|---|---|---|---|---|
| | M | *SD* | M | *SD* | | M | *SD* | M | *SD* |
| MELODIA | 7.7 | 1.7 | 4.5 | 2.7 | VARÍOLA | 2.0 | 1.4 | 5.0 | 3.1 |
| CORAÇÃO | 7.7 | 1.9 | 4.9 | 3.3 | LEPRA | 1.9 | 1.5 | 4.8 | 3.0 |
| AUTONOMIA | 7.7 | 1.9 | 4.3 | 2.8 | DESANIMADO | 1.8 | 1.3 | 4.5 | 3.0 |
| FOTOGRAFIA | 7.7 | 2.0 | 4.6 | 2.7 | DEPRIMENTE | 1.8 | 1.3 | 4.9 | 3.1 |
| DIGNO | 7.7 | 1.7 | 4.0 | 3.4 | MALCHEIROSO | 1.8 | 1.3 | 4.9 | 3.0 |
| ADMIRADO | 7.7 | 1.5 | 4.5 | 3.3 | DESPREZO | 1.7 | 1.3 | 5.0 | 3.2 |
| FORTE | 7.7 | 1.7 | 4.7 | 3.5 | DERROTADO | 1.7 | 1.3 | 5.0 | 3.1 |
| RECREIO | 7.7 | 1.9 | 4.1 | 2.5 | FUNERAL | 1.5 | 1.4 | 4.9 | 3.3 |

Attributes from the left/Positive and right/Negative columns were exclusively used as US across *allPos* and *allNeg* categories respectively. Across mixed categories *mostPos* and *mostNeg*, the program would randomly select 80% and 20% of attributes from each category.

required maximizing differences across valence ratings between positive and negative US while matching across arousal. We selected 80 positive ($M$ = 8.1, $SD$ = 1.5) and 80 negative ($M$ = 2.8, $SD$ = 1.9) attributes with valence ratings more than three standard deviations apart. Arousal ratings were matched across positive ($M$ = 4.5, $SD$ = 3.2) and negative ($M$ = 4.7, $SD$ = 3.2) attributes to a single standard deviation. Four US categories were employed during the conditioning phase. Two categories constituted exclusively of positive (call this category: *allPos*) and negative (*allNeg*) attributes respectively. Two remaining US categories constituted of mixtures of 80% positive, 20% negative (*mostPos*) and 20% positive, 80% negative (*mostNeg*) attributes respectively. Positive and negative attributes were mixed across adjacent categories (e.g., *allPos* and *mostPos* shared positive US) to minimize influence of constituent US artefacts.[2] Distractors appeared during evaluation phases only. Four 200 ml cans covered in black masking tape and four 200 ml cans covered in blue masking tape were used during preference tests. Each can displayed one of the eight trigrams described earlier in 24 Arial Black font on a white sheet (3 × 2 inches) taped to the front of the can. Black cans were labelled ZAF, NUV, XAB and KUJ; blue cans were labelled RYV, NYD, HIX and ZIQ. For half the participants, black and blue cans represented supraliminal and subliminal CS respectively. Visibility condition assignment was reversed for the remaining half of participants. All computerized tasks were presented on a 21 in. LCD display with a ~60 Hz refresh rate connected to a Windows 10 desktop. All tasks were designed and implemented in the E-Prime 3 environment (Psychology Software Tools, Inc., 2016). Data organization and analysis was conducted on the open-source R environment (R Core Team, 2017; RStudio, 2015), using the packages *ggplot2* (Wickham, 2016) and *BayesianFirstAid* (Bååth, 2014). Data and scripts for replicating our analysis are available at https://osf.io/zxnpc/.

### 2.3. Procedure

#### 2.3.1. Thirst induction

Following the receipt of written consent, participants received a plastic container containing commercial salty crackers, with instructions to eat a single cracker (Fig. 1, Phase 1). Participants had also been instructed not to eat/drink anything at least 2 h prior to the procedure, which was confirmed with a post-task interview. These manipulations were designed to induce thirst, which can enhance effectivity of primes associated with drinking motivations (Karremans et al., 2006).

#### 2.3.2. CS preferences

Motivation was measured following manual allocations of CS-labelled drink cans by order of preference (Strahan et al., 2002; Veltkamp et al., 2011). Participants were provided a cover story about the CS being potential candidates for a new soft drink brand. To facilitate this cover, unopened 200 ml soda cans were covered in opaque masking tape, with CS labels in can center being the only distinguishing feature (Fig. 1, Phase 2). Participants viewed two sets of black and blue cans in front of two sheets of paper taped to the surface of a flat, featureless desk. Sheets displayed four equally sized concentric circles labelled '1', '2', '3' and '4' in white font against a blue/black background. Cans were placed with their labels facing away from the participant. Can positions before placement was varied between participants. Participants were asked to first turn around all the cans until all labels were in view. Next, they were instructed to sequentially place each can on color-matched circles by order of preference, so the most preferred can on the circle labelled '1', the next preferred on '2', then '3', and the least preferred can on '4'. After all 8 cans had been placed (4 on black circles, 4 on blue circles), the experimenter took a photo of the can arrangements and removed all cans from the participant's view.

#### 2.3.3. CS evaluations

Participants were seated at a desktop computer and provided instructions regarding all upcoming tasks. The task began with 8 evaluation trials presented in randomized sequence. Across each trial, participants moved a slider along a visual-analog scale anchored by happy and sad cartoon faces, representing positively and negatively valenced end-anchors respectively, in the presence of individual trigrams (Fig. 1, Phase 3). Participants were asked to provide their 'best guess' if unsure how to evaluate the displayed trigram, as a trial would not progress until the slider had been interacted with. Intervals between evaluations were jittered at 150–350 ms to minimize temporal conditioning artefacts (Matute, Lipp, Vadillo, & Humphreys, 2011). Completion of 8 evaluations (4 for subliminal CS, 4 for supraliminal CS) resulted in initiation of the conditioning phase.

#### 2.3.4. CS-US conditioning

Conditioning consisted of 80 trials. Each trial involved one of four CS pairs being exclusively associated with 100% positive (*allPos*), 100% negative (*allNeg*), 80% positive 20% negative (*mostPos*) or 80% negative 20% positive (*mostNeg*) attributes across 20 trials each. Assignment of CS to supraliminal or subliminal conditions was counter-balanced between participants. Allocation of CS for associations with *allPos*, *mostPos*, *mostNeg* and *allNeg* categories was varied between participants across inter-mixed trials (Fig. 1, Phase 4). Each trial commenced with three white 'boxes' on a grey background, appearing near the top center, bottom left and bottom right corners of the screen, with '###' characters inside each box. Participants pressed the spacebar to begin a

[2] If the constituent valences of some US (such as PIZZA) had been sufficiently salient to override conditioning information, then we could expect matching positive evaluations across *allPos* and *mostPos* categories (as both categories incorporated 'PIZZA' as US). Our analyses of evaluations indicate otherwise (Figure 2). Evaluations of visible CS associated with *allPos* were greater than *mostPos*, with comparative effects noted across adjacent categories, as would be predicted if participants were responding to valence information gleaned from conditioning over constituent stimulus properties (also see Amd & Roche, 2017, pp. 2490–2492).

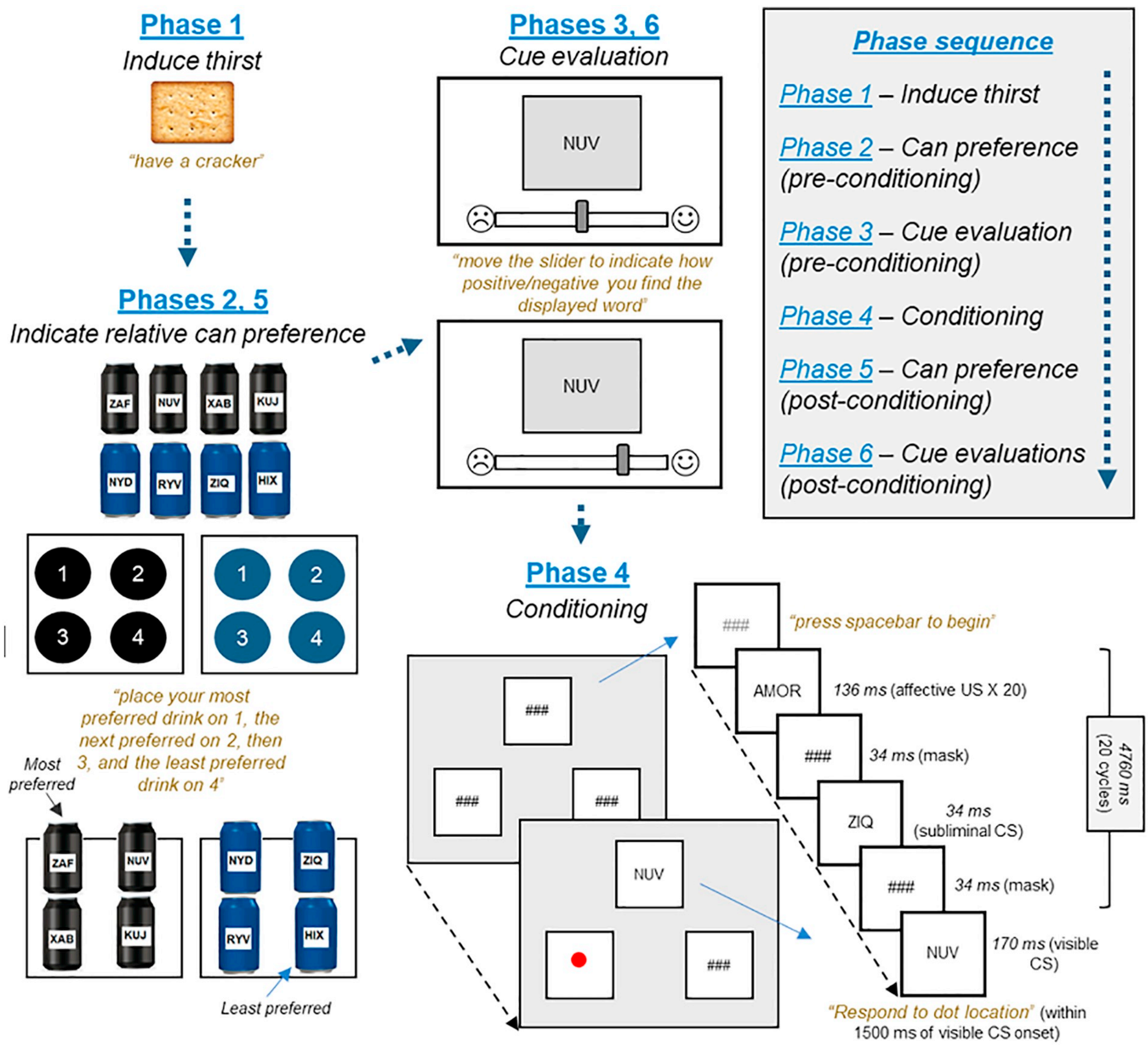


**Fig. 1.** Phase sequence of the full task is summarized in the top-right panel. Participants were first provided with a salty cracker to induce thirst [Phase 1]. Next, they placed cans on numbered circles by order of preference [Phase 2], where most and least preferred drinks were placed on circles labelled '1' and '4' respectively. Participants next evaluated 8 trigrams individually using a visual-analog valence scale [Phase 3]. Participants next underwent conditioning, where each trial consisted of a [US > mask > subliminal CS > mask] stream that was recycled 20 times over 4760 ms, with a novel US appearing during each cycle [Phase 4]. This cycle terminated with a visible CS and red dot in the bottom-left or right corners of the screen. Responding to dot location produced a new trial. After completion of 80 conditioning trials, participants were asked to again place cans along order of preference [Phase 5], followed by a final round of cue evaluations [Phase 6]. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

trial, which produced 20 'streams' of US, '###' masks, and subliminal CS in the top center box only (the remaining boxes only depicted '###' at this stage). Each 'stream' commenced with a US (SOA = 136 ms), a forward mask (34 ms), a subliminal CS[3] (34 ms) and a backward mask (34 ms) for a total of 238 ms. 20 streams were sequentially presented, with a novel US presented with the same subliminal CS across each stream (Fig. 1, Phase 4). We used multiple, supraliminal US to enhance likelihood of US-to-CS valence transfer (Gawronski, Morrison, Phills, & Galdi, 2017, Experiment 1; Lähteenmäki, Hyönä, Koivisto, & Nummenmaa, 2015). The 20 [US > mask > sub CS > mask] streams terminated with a visible CS near the top-screen center. After 170 ms, a red dot appeared in the bottom left/right boxes of the screen. Participants were instructed to respond to dot location 'as fast as possible' by producing a location-specific keypress ('z' for left, 'm' for right) as soon as dot location could be determined. Dot-location responses increase the likelihood of participants attending the task (e.g., Di Domenico, Palumbo, Fairfield, & Mammarella, 2016).

Accurate responses produced a feedback message displaying the reaction time (RT) in a yellow font; an incorrect discrimination produced a large red 'X' in screen center. Failure to provide a response within 1500 ms of supraliminal CS onset produced the message 'too slow'. Trials where dot-detection responses were not observed within 1500 ms of supraliminal CS onsets were recycled back into the trial sequence. Displaying the RT functioned to inform participants they were responding accurately at an 'acceptable' speed. Participants had been instructed to respond to dot location quickly, without direct information of the actual threshold value being 1500 ms. All CS appeared

[3] Potter, Wyble, Hagmann, and McCourt (2014) illustrated that meaning can be derived from S-presentations under 14 ms. That study involved meaningful *faces* as stimuli, which are feature-rich – when fewer distinguishing features are present, as is the case with nonsense trigrams, meaning derivation may not reliably occur for S-presentations below 120 ms (Broers, Potter, & Nieuwenstein, 2018). Our study presented masked trigrams at latencies demonstrated earlier to function as effective subliminal primes (Di Domenico et al., 2016; Elgendi et al., 2018).

an equal number of times each block to minimize exposure effects (Yoshimoto, Imai, Kashino, & Takeuchi, 2014). We constrained responses via latency restrictions to minimize extensive deliberation (Amd & Baillet, 2019, p. 3). Our conditioning task follows from recent investigations on procedural variables influencing symbolic CS-US acquisition and US-to-CS valence transfer (e.g., Amd, Machado, de Oliveira, Passarelli & de Rose, 2019; Amd, de Almeida, de Rose, Silveira, & Pompermaier, 2017). Completion of 80 conditioning trials was followed by a second round of can preference tests and CS evaluations (Fig. 1, Phases 5 and 6).

### 2.4. Data analysis

We ran frequentist and Bayesian analyses across clusters of single-sample and two-sample contrasts. Single-sample tests addressed whether mean differences (computed from subtracting post-conditioning preferences/evaluations from pre-conditioning preferences/evaluations) credibly and/or significantly shifted from a null estimate (0) for supraliminal and subliminal CS associated with each US category (*allPos, mostPos, mostNeg, allNeg*). Mean differences (d-scores) greater than the null (d-scores > 0) indicated positive transfer: differences smaller than the null (d-scores < 0) indicated negative transfer. During two-sample contrasts, we asked whether evaluation and preference *d-scores* differed between CS associated with different US categories: *allPos* vs *allNeg, allPos* vs *mostPos* and *mostNeg* vs *allNeg.*[4] An *allPos* vs *allNeg* difference would strengthen claims of US-to-CS valence transfer. Observing differences (or not) across remaining *allPos* vs *mostPos* and *mostNeg* vs *allNeg* contrasts would indicate whether summative (or integrative) processes undermined evaluations and/or preferences.

All frequentist contrasts incorporated Welch's tests instead of Student's *t*, given the former's robustness to normality violations and other parametric assumptions (Delacre, Lakens, & Leys, 2017). Complementary Bayesian contrasts were based on Kruschke's BEST model (Bayesian estimation supersedes the *t*-test – Kruschke, 2013) for approximating probabilities of posterior likelihood distributions. Posterior distributions were estimated to 95% credibility intervals (CIs) using a 10,000 Monte Carlo Markov Chain per approximation, which are more informative than comparisons reporting Bayes factors (Kruschke, 2013, p. 573). CIs follow a Gaussian distribution, describing the range and likelihood of observations whereas confidence intervals only provide range (p. 592). When CIs overlap null estimates, Kruschke's (2013) BEST solution informs us whether observed posterior distributions are somewhat likely ($P > .7$), very likely ($P > .8$) or extremely likely ($P > .9$) to predictably shift from a null effect (*d-score* > 0 for *allPos, mostPos*; *d-score* < 0 for *allNeg, mostNeg*). We incorporated Bayesian likelihoods to inform us about the relative likelihoods of our current predictions relative to null effects, whereas (frequentist) confidence intervals overlapping null estimates are non-informative about the likelihood of null or alternative effects (Kruschke, 2013). We refer to frequentist *p*-values and Bayesian likelihoods as α and *P* respectively to facilitate readability (e.g., α = 0.05 instead of $p = .05$).

## 3. Results

### 3.1. Preference check

Single-sample tests did not reach significance across supraliminal or subliminal CS (all α's > 0.08 – see Table 2). BEST approximations revealed mean differences (d-scores) for supraliminal CS were extremely likely ($P = .93$) and somewhat likely ($P = .78$) to shift positively (d-scores > 0) following associations with *allPos* and *mostPos* categories respectively. Subliminal CS associated with *allPos* and *allNeg* categories were very likely ($P = .84$) and extremely likely ($P = .91$) to shift positively (> 0) and negatively (< 0) respectively (Fig. 2, top row). Two-sample tests revealed supraliminal CS associated with *allPos* were preferred significantly more than supraliminal CS associated with *allNeg* (α = 0.03); a similar contrast across subliminal CS respectively associated with *allPos* and *allNeg* revealed a non-significant difference (α = 0.06 – see Table 3). BEST approximations revealed (*allPos* vs *allNeg*) effects were extremely likely for preferences towards supraliminal ($P = .96$) and subliminal ($P = .95$) CS.

**Table 2**
Single-sample contrasts (d-score vs. null).

| Condition | US categories | P(+)* | P(−)* | Welch's α** |
|---|---|---|---|---|
| Visible/preferences | *allPos* | **0.93** | *0.07* | 0.09 |
| | *mostPos* | **0.78** | *0.22* | 0.20 |
| | *mostNeg* | *0.39* | 0.61 | 0.36 |
| | *allNeg* | *0.32* | 0.68 | 0.09 |
| Subliminal/preferences | *allPos* | **0.84** | *0.16* | 0.19 |
| | *mostPos* | 0.59 | *0.41* | 0.39 |
| | *mostNeg* | *0.45* | 0.55 | 0.36 |
| | *allNeg* | *0.09* | **0.91** | 0.08 |
| Visible/evaluations | *allPos* | **0.99** | *0.01* | **<.001** |
| | *mostPos* | **0.91** | *0.09* | **0.01** |
| | *mostNeg* | *0.54* | 0.46 | 0.34 |
| | *allNeg* | *0.01* | **0.99** | **<.001** |
| Subliminal/evaluations | *allPos* | 0.63 | *0.37* | 0.72 |
| | *mostPos* | 0.32 | *0.68* | 0.95 |
| | *mostNeg* | *0.44* | 0.56 | 0.69 |
| | *allNeg* | *0.19* | **0.81** | **<.001** |

*Bayes likelihoods of mean differences being greater (+) or less (−) than 0, indicating positive or negative valence transfer respectively. Grey shaded regions illustrate values unrelated to our hypotheses.
***p*-values following single-sample frequentist contrasts against a mean null estimate. Significant *p*-values (α < 0.05) and probabilities indicating the effect was at least somewhat likely ($P > .7$) are marked in **bold**.

### 3.2. Evaluation check

Single-sample contrasts across supraliminal CS evaluations revealed significant effects following associations with *allPos* (α < 0.001), *mostPos* (α < 0.01) and *allNeg* (α < 0.001). Across subliminal CS, only associations with *allNeg* (α < 0.001) produced significantly negative differences (Fig. 2, bottom row). Single-sample BEST approximations revealed supraliminal CS associated with *allPos* ($P > .99$), *mostPos* ($P = .91$) and *allNeg* ($P > .99$) were extremely likely to deviate in predicted directions. Across subliminal CS, only associations with *allNeg* was very likely ($P = .81$) to produce negative differences (Fig. 2, bottom row). Following two-sample tests, valence transfer effects for CS respectively associated with *allPos* and *allNeg* were significant across supraliminal (α < 0.01) and subliminal (α = 0.02) conditions (Table 3). Complementary BEST approximations revealed valence transfer was extremely likely for supraliminal CS ($P > .99$), and somewhat likely for subliminal CS ($P = .78$).

### 3.3. Integration vs summation

Preferences did not vary across subliminal CS (α = 0.31) or supraliminal CS (α = 0.43) following associations with *allPos* and *mostPos* respectively. BEST approximations revealed mean differences between *allPos* and *mostPos* being > 0 (*allPos* – *mostPos* > 0) as somewhat likely ($P = .72$) across supraliminal CS, and marginally so across subliminal CS ($P = .61$). Preferences did not vary across subliminal (α = 0.23) or supraliminal (α = 0.23) CS following associations with *mostNeg* and *allNeg*. Corresponding BEST approximations revealed a (*mostNeg* – *allNeg* > 0) effect as very likely for subliminal CS preferences

[4] Any effects observed across other two-sample contrasts (e.g., *allPos* vs *mostNeg*, *mostPos* vs *mostNeg*, *mostPos* vs *allNeg*) could be used to equally support integrative or summative perspectives.

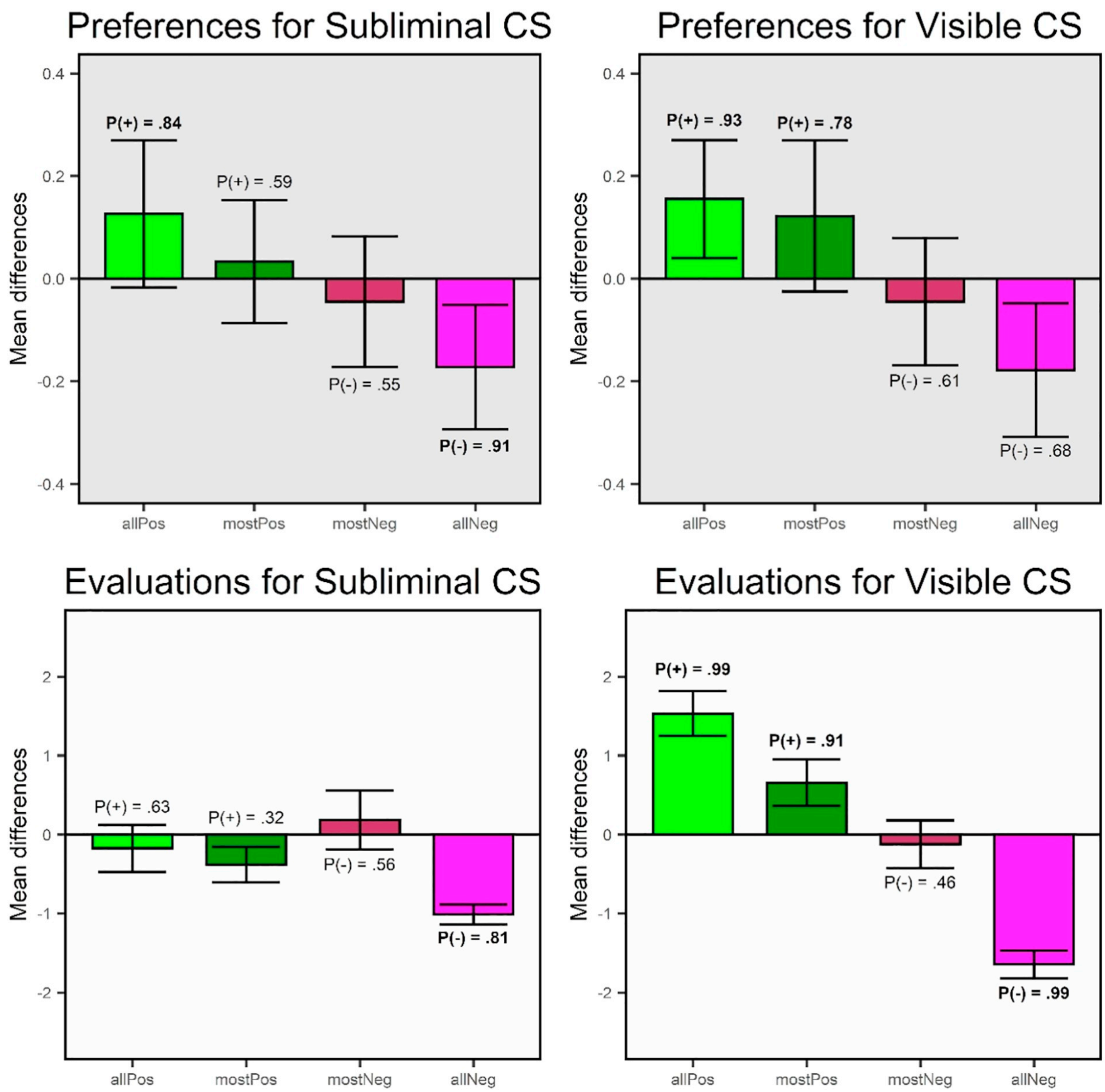


**Fig. 2.** Mean differences across pre- and post-conditioning CS evaluations (bottom row) and CS-labelled drink preferences (top row). Data callouts illustrate likelihoods of CS correlated with *allPos* and *mostPos* producing mean differences > 0, and of CS correlated with *allNeg* and *mostNeg* producing mean differences < 0. The respective likelihoods for positive and negative transfer are respectively denoted by P(+) and P(−). Differences that were at least somewhat likely ($P > .7$) to favor predictable shifts from 0 are marked in **bold**. Error bars indicate SEMs.

($P = .81$), and somewhat likely for supraliminal CS preferences ($P = .73$).

Evaluations were significantly more positive following associations with *allPos* relative to associations with *mostPos* for supraliminal ($\alpha < 0.01$) but not subliminal ($\alpha = 0.29$) CS. BEST approximations revealed (*allPos* – *mostPos* > 0) as extremely likely for supraliminal CS ($P > .99$), but only marginally so for subliminal CS ($P = .65$). Evaluations were significant for (*mostNeg* – *allNeg* > 0) following supraliminal ($\alpha = 0.01$) and subliminal ($\alpha = 0.01$) presentations, although BEST approximations revealed only the former as extremely likely ($P > .99$).

## 4. Discussion

The present study linked four pairs of subliminal and supraliminal CS exclusively with four US categories of varying valences (*allPos*, *mostPos*, *mostNeg*, *allNeg*). Pre- and post-conditioning, participants evaluated CS valences and indicated preferences towards CS-labelled cans. Analysis of pre-post differences revealed valences for supraliminal CS associated with *allPos, mostPos* and *allNeg* categories were extremely likely to shift in their predicted directions (positive, positive, negative). Conversely, valences for subliminal CS reflected chance responding across most categories, save for CS associated with *allNeg* (more on this in a moment). Across can preferences, supraliminal CS associated with *allPos* and *mostPos* were very likely to become increasingly preferred after conditioning. For subliminal CS, associations with *allPos* and *allNeg* categories were extremely likely to predictably shift preferences, whereas associations with mixed categories (*mostPos*, *mostNeg*) were marginally likely to shift preferences in predicted directions. Finally, frequentist contrasts between CS associated across adjacent categories (*allPos* vs *mostPos*, *mostPos* vs *mostNeg, mostNeg* vs *allNeg*) were generally non-significant. However, Bayesian analyses implied preferences towards subliminal CS, along with evaluations towards supraliminal CS, were sensitive to the aggregate valences of associated US categories,

**Table 3**
Two-sample tests (d-score-1 vs d-score-2).

| Condition | Contrasts | *P(1-2) > 0** | Welch's *α*** |
|---|---|---|---|
| Visible/preferences | *allPos-1* vs *allNeg-2* | **0.96** | **0.03** |
| | *allPos-1* vs *mostPos-2* | 0.61 | 0.43 |
| | *mostNeg-1* vs *allNeg-2* | **0.73** | 0.23 |
| | *mostPos-1* vs *mostNeg-2* | *0.79* | *0.19* |
| Subliminal/preferences | *allPos-1* vs. *allNeg-2* | **0.95** | 0.06 |
| | *allPos-1* vs *mostPos-2* | **0.72** | 0.31 |
| | *mostNeg-1* vs *allNeg-2* | **0.81** | 0.23 |
| | *mostPos-1* vs *mostNeg-2* | *0.62* | *0.33* |
| Visible/evaluations | *allPos-1* vs *allNeg-2* | **>0.99** | **<0.01** |
| | *allPos-1* vs *mostPos-2* | **>0.99** | **0.02** |
| | *mostNeg-1* vs *allNeg-2* | **0.99** | **0.01** |
| | *mostPos-1* vs *mostNeg-2* | *0.79* | *0.03* |
| Subliminal/evaluations | *allPos-1* vs *allNeg-2* | **0.78** | **0.02** |
| | *allPos-1* vs *mostPos-2* | 0.65 | 0.29 |
| | *mostNeg-1* vs *allNeg-2* | 0.62 | **0.01** |
| | *mostPos-1* vs *mostNeg-2* | *0.51* | *0.91* |

*Bayes likelihood of the mean difference between Category-1 and Category-2 being > 0. Significant *p*-values ($\alpha < 0.05$) and probabilities indicating the effect was at least somewhat likely ($P > .7$) are marked in **bold**.
**Two-sample contrasts between CS associated with respective US categories, where we assessed whether Category-1 was greater than Category-2. Grey shaded regions illustrate values unrelated to our hypotheses.

suggesting sensitivity to summated valences. Alternatively, preferences towards supraliminal CS clearly reflect integration. In sum, supraliminal CS were preferred and evaluated in accordance with the valences of their associated US categories. Across subliminal CS, only preferences shifted predictably, with minimal effect across evaluations. The latter disassociation supports our primary hypothesis: motivational responses (preferences) associated with subliminally presented CS were predictably shifted by valence transfer even as directed evaluations towards those same subliminal CS remained mostly unaffected.

Our work additionally illustrates how CS associated with exclusively negative US (*allNeg*) are more likely to yield predictable transfer effects across subliminal and supraliminal visual conditions. CS associated with *allNeg* categories consistently induced negative evaluations across supraliminal and subliminal CS. A similar trend was found across preferences, although Bayesian analysis indicated a preference effect across subliminal CS associated with *allNeg* to be marginally likely ($P = .68$; Fig. 2, top-right), compared to preferences towards supraliminal CS ($P = .91$; Fig. 2, top-left). Given that our US categories had controlled for intensity/arousal levels across US categories, these findings provide evidence that the establishment of negative CS/primes may be more effective relative to the establishment of positive and/or mixed CS/primes.

To understand how motivational responses can be influenced by external/relational valence information even as directed evaluations are not, three issues should be considered: first, note that we evolved to experience appetitive motivational states (e.g., thirst) before having evolved the psycholinguistic capacity to construct culturally-conditioned referents, like the English word ‘thirsty’, and generate top-down evaluations towards them (Glasgow, 2018; Pinker, 2003). In other words, said ‘experience’ is a consciously describable goal-state anteceded by pre-verbal/unconscious processes that operate to bring an agent closer to said goal-state (Custers & Aarts, 2010; Hull, 1930). Second, assuming pre-verbal processes can be influenced by bottom-up (conditioned) valences *before* top-down processes have a window to moderate evaluations (Amd & Baillet, 2019; Gibbons, 2009; Gibbons, Seib-Pfeifer, Koppehele-Gossel and Schnuerch, 2018), the former can generalize to prompt associated sensorimotor/response component activations (Vigliocco, Meteyard, Andrews, & Kousta, 2009). There is good evidence that pre-verbal, valence associated processes onset within 100–200 ms of symbol presentations (Amd & Baillet, 2019; Amd, Barnes-Holmes, & Ivanoff, 2013; Bayer et al., 2017; Bernat, Bunce, & Shevrin, 2001; Gibbons et al., 2018; Hinojosa, Méndez-Bértolo, & Pozo, 2010; Schacht & Sommer, 2009), which influences subsequent lexical processing and feature integration processes during the following 200–300 ms (Koppehele-Gossel, Schnuerch, & Gibbons, 2019). The temporal window between valence-associated (bottom-up) and narrative-related (top-down) effects offers ample opportunity for pre-verbal processes to influence sensorimotor activations through divergent “excitatory tendencies, radiating from (the target) stimulus, each leading to a distinct reaction” (Hull, 1934, p. 33). This view is complemented by more recent speculations, which suggest goal-related sub-processes can operate below conscious thresholds to bring an agent closer to achieving said goal (Aarts & Dijksterhuis, 2000; Custers & Aarts, 2010). In sum, our hypothesis suggests that motivations to drink (and eat – Amd & Baillet, 2019), along with their associated behavioral states, likely appeared earlier in our evolutionary history relative to our capacity to symbolically label said states (Glasgow, 2018). Therefore, sensorimotor action sequences associated with CS-associated motivations may be ‘set off’ by conditioned valences before conscious awareness has an opportunity to modulate expression. We conclude our report by addressing some potential limitations of our design, such as a lack of CS visibility checks, US expectancy and implicit evaluation measures.

## 5. Limitations

In respect to visibility checks, one could counter that some of our observed evaluations were not for *actually* subliminal CS, as some CS may have been identified even at 34 ms visual thresholds. In response, note that a 34 ms threshold, in conjunction with backward and forward masks, is a common standard across subliminal priming/conditioning investigations (e.g., Elgendi et al., 2018; Heycke & Stahl, 2018). Indeed, Shah and Kruglanski (2002) report symbolic primes may be consciously unidentifiable following presentations up to 50 ms, rendering our 34 ms presentation window appropriate. Another reason for excluding visibility checks, and implicit evaluation tasks, is the positive relation between symbolic identification and associated valence misattributions. Specifically, merely identifying some CS, even during some implicit evaluation task, may cause participants to derive unrelated valenced qualifiers with said CS vis-à-vis unintentional misattribution (March, Olson, & Fazio, 2018). In other words, valences may shift independently of relational (valence) information provided through CS-US conditioning. Therefore, while it is not possible to declare whether all/any of our subliminal CS were *actually* subliminal, including an in vivo visibility check would have enhanced the likelihood of CS valence misattributions. Alternatively, an external visibility check appeared unnecessary as earlier works have already demonstrated the effectiveness of our timing parameters (e.g., Di Domenico et al., 2016).

Another reason for excluding implicit evaluation measures involves issues surrounding the interpretability of observed effects; on one hand, observed outcomes across implicit evaluation tasks can directly reflect associative histories (Brownstein, Madva, & Gawronski, 2019; Cummins, Roche, Tyndall, & Cartwright, 2018). On the other hand, implicit evaluations can be shifted through top-down deliberations (Kurdi & Banaji, 2019; Ridgeway, Roche, Gavin, & Ruiz, 2010). The malleability of implicit evaluations to bottom-up and top-down influence between different participants, even across the same participant (Amd & Roche, 2015, 2016), renders the term *implicit* in ‘implicit evaluation’ theoretically dubious. Explicit evaluations are generally more informative than implicit evaluations in any case, at least when the topic of evaluations is not socially sensitive (e.g., race bias –Gawronski, 2019).

Finally, we excluded US expectancy measures for three reasons: first, the sheer variety of US associated with each CS (80 unique US per CS) meant it was unlikely subjects would recall each US specifically – furthermore, some US were linked with multiple CS (e.g., CS associated with *allPos, mostPos* and *mostNeg* may have shared positively valenced

US), confounding any interpretation of expectancy measurements based on accurate US identification. If one then counters that we could have reserved US expectancy measurements to valence judgements instead (e.g., responding to the question *How positive/negative do you think the upcoming stimulus will be?* instead of *Which word do you think the upcoming stimulus will be?*), our visual-analog measure of CS valence renders such additional valence judgements redundant.

A final question may be raised regarding our reasoning for an 80/20 split across our mixed (*mostPos, mostNeg*) US categories instead of, say, a 70/30 or 60/30 split. The selection of an 80/20 split was largely arbitrarily, with the only constraint being applied was requiring the split threshold to be located at least one standard deviation away from means centered around chance (50/50), positive (100/0) and negative (0/100) ratios. Future investigators interested in integrative and summative processes underlying subliminal evaluations/preferences can build on the present findings and test alternate split ratios (e.g., 70/30, 60/40, 90/10, 75/25) to note impact on performance indicators. These could involve incorporating multi-level evaluation measures (i.e., alongside explicit, implicit and physiological levels - Amd & Baillet, 2019; Amd & Roche, 2016, 2017) to determine how CS misattributions moderate conditioned evaluations and/or preferences. It could also be valuable for future research to incorporate measures of individual personality differences, given the well-established influence of dispositional states on evaluations (Burns, 1990; Staats, 1986, 2012, 1981).

## 6. Conclusion

The history behind subliminal conditioning is a contentious one. In 1957, James Vicary claimed to have increased Coca-Cola and popcorn sales through subliminal advertisements presented during a movie screening. Those results were never published nor replicated, and the entire affair was deemed fraudulent (O'Barr, 2013). Yet, the possibility of subliminally influencing deliberate behavior continued to fascinate many psychologists, leading to the discovery of operating conditions under which subliminal influence can be achieved (Elgendi et al., 2018; Karremans et al., 2006; Veltkamp et al., 2011). Earlier failures towards observing subliminal effects may have been confounded by insufficiently distinguishing across the relative contributions of motivational (preferences), affective and/or cognitive (verbal) processes across designated performance indicators (Berlyne, 1965; Staats, 2012; Staats & Eifert, 1990), which the present study aimed to do. The dissociation between preference and evaluation indicators suggest the operation of distinct[5] processing chains contributing to the variable outcomes here. There may be more to Vicary's fantasies than both his critics and proponents realize.

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[5] We use 'distinct' here as our current investigation was not designed to tease out whether the processing chains involved were associative (McLaren et al., 2019), propositional (De Houwer, 2018) or some combination of the two (Gawronski & Bodenhausen, 2018).

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