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(Not) feeling up or down? Lack of evidence for vertical spatial iconicity effects for valence evaluations of emoji stimuli

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ABSTRACT

A key question about the function of emoji is whether or not they are emotional. This is not yet fully established, and the literature presents mixed evidence. We used the Emoji Spatial Stroop Task to explore spatial iconicity effects based on vertical positioning of emoji. Emoji stimuli were presented in three vertical positions whereby participants ($N = 87$) made a valence evaluation. Accuracy and latency of responses were measured. A 2 (emoji valence; positive, negative) x 3 (vertical position; upper, lower, central) within-participants design was used to determine the impacts of emoji valence and position on accuracy and latency of valence evaluations. Responses were analysed in a 2 $\times$ 3 mixed effects binary regression with emoji valence and spatial congruency as fixed effects. No main or interaction effects of emoji valence and spatial congruence were observed. These findings challenge the assumption that we process emoji as symbolic objects that represent emotion concepts.

Public significance statement

Given that emoji are used readily in online communication, understanding how we interpret them is important. Despite the fact we assume they serve emotional markers in communication, our findings suggest that we do not necessarily respond emotionally when receiving them. We argue that they may be more likely to be social indicators to help support effective interpersonal relations.

1. Introduction

Emoji are popular within online text-based communication (Novak et al., 2015). Much research on emoji has focused on understanding their uses, functions, and affordances (see Bai et al., 2019, for review). The study of emoji spans a range of disciplines including psychology, communication studies, and computer science. Whilst communication research might tend to lean towards the assumption of emoji being tools for social communication, other fields are often guided by the implicit assumption that emoji are emotional or serve emotional functions. However, there is ongoing debate on whether emoji are actually inherently emotional. That is, although emoji are often assumed to serve emotional functions in online communication, growing empirical literature somewhat contests this (Kaye et al., 2021, 2023).

Research to this effect has typically used lexical decision paradigms to explore any processing advantages (i.e., quicker response times) which may occur when responding to valenced emoji (e.g., happy or sad emoji, representing positive and negative valence, respectively) versus neutral emoji. These have typically found null effects and it is intriguing to consider other paradigms which may help ascertain the extent to which emoji may be emotional. One such approach may be to establish the mechanisms underpinning spatial processing of emoji, given the extensive literature acknowledging spatial iconicity to be influential to the way we process stimuli (Dudscig et al., 2015; Zwaan & Yaxley, 2003; Šetić & Domijan, 2007). Evidence to this effect would go some way to test how physical properties of emoji stimuli impact upon affective processing, whereby any facilitative or interference effects here would suggest that our processing is determined by the way emoji are integrated within our sensorimotor and/or affective knowledge systems.

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1.1. Sensorimotor integration

The study of embodied cognition seeks to explain how the way we process and understand the world is shaped by an integration of our sensory and motor systems. Embodied cognition has been a prominent area of study for many decades (see Zwaan, 2021) although has been subject to debate. Specifically, abstract concepts (e.g., "truth") have been debated on the extent to which they can occupy unified sensorimotor and affective representations (Mahon & Caramazza, 2008). Others have argued that abstract concepts can help contribute to resolving a number of conceptual problems in this area (Dove, 2016). Kousta et al. (2011) propose that the representation of all concepts, both concrete and abstract, include two types of information: experiential and linguistic. Experiential information encompasses sensory, motor, and affective knowledge. Whilst sensory and motor information can be easily linked to concrete concepts, affective and linguistic information seems to uphold abstract concepts. In the case of emotion, these arguably relate to the latter, in which affective and/or linguistic experiential information are afforded to these.[1]

Much research in the area of embodied cognition has tended to adopt experimental paradigms to test the principle of how the processing of stimuli may vary based on their physical or spatial presentation. This tests the interactions between the physical properties of stimuli and any sensorimotor or affective processes. This has often used the Spatial Stroop task, to explore how spatial properties of stimuli impact on processing efficacy and effectiveness (White, 1969). That is, this paradigm tests any interference which may derive between the stimulus symbolic features and the spatial location of its presentation (MacLeod, 1991; Wuhr, 2007). As such, it is argued that responses garnered through this task can infer automatic or implicit aspects of processing and thus can help answer questions about how conceptual knowledge is represented and retrieved.

Research adopting the Spatial Stroop paradigm has often focused on word stimuli (Mahon, 2015; Mahon & Caramazza, 2008; Thornton et al., 2013), and has included variations to test the effects, including manipulating visual features of stimuli such as font size of word stimuli (Palef & Olson, 1975), or where words are presented in the upper or lower visual fields (Zwaan & Yaxley, 2003). The latter of these is of specific relevance to the current study, and helps explore how spatial iconicity affects semantic-related judgments. That is, studies have observed congruence effects for words such as "sky" when presented in the upper visual field, and "basement" when in the lower visual field (Zwaan & Yaxley, 2003; Šetić & Domijan, 2007). Namely, more efficient processing is observed when the referent is in a spatial position that may be prototypical of where we perceive this in the physical world.

Within this literature, one of the most widely debated topics concerns the mechanisms that underpin these observed effects. Some research indicates that word recognition requires activation of the perceptual, affective or motor-related processing that occurs when we are actually experiencing the entity (Barsalou, 1999; Ostarek & Vigliocco, 2017; Treccani et al., 2019; for a review, see Meteyard et al., 2012). This is underpinned by Barsalou's (1999) perceptual symbol systems framework which states that conceptual knowledge incorporates different types of sensorimotor information (e.g., visual features, auditory information) meaning this knowledge is processed through a variety of channels. While this makes conceptual sense for words associated with concrete objects or events that may physically embodied in everyday life (e.g., bird, basement), it is less clear how and why emotional states are also observed to elicit similar spatial iconicity effects (discussed in the next section). Some evidence suggests that the emotional components of words may provide an additional context to support the retrieval of conceptual knowledge (Siakaluk et al., 2016). As such, affective knowledge here is a type of experiential information used to process any given (emotional) stimuli. If emoji are indeed associatively linked to affective knowledge concepts, this should bring about more efficient retrieval when processing.

[1] It is important to note that emotion words have been classified as abstract words for a long time, oftentimes without justification (Altarriba et al., 1999). However, research supports emotion words being a different category from both concrete and abstract words (e.g., emotion words have higher imageability than abstract words; Altarriba et al., 1999; Altarriba & Bauer, 2004).

1.2. Valence-space effects

When considering emotion, we often situate our emotional states in physical (vertical) space. For example, positive or happy states are situated in upper space (e.g., "I'm in *high* spirits"), while negative or sad states may be associated with lower space (e.g., "I'm feeling *down*"). Meier and Robinson (2004) verified this association between emotion and physical space, whereby they found a processing advantage when positive-valenced word stimuli (e.g., "party") were displayed in the upper visual field and when negative stimuli (e.g., "death") were presented in the lower visual field. Similarly, emotion and emotion-laden words are often associated with other physical properties such as one's posture and gait patterns. Specifically, processing advantages are observed when positive emotion words (e.g., happy, joy) are coupled with upright posture, and when negative emotion words (e.g., grief, sadness, depression) are associated with slouching and slower walking speed (Dudscig et al., 2015; Fisher, 1964; Michalak et al., 2009).

Processing advantages associated with physical space and properties are found for emotion words themselves (e.g., happy, sad) and emotion-laden words (e.g., hate, aggression) (Dudscig et al., 2015; Meier & Robinson, 2004). For emotion-laden words, it is unclear whether spatial processing is associated with understanding the word itself (word processing), evaluating the valence of the word (valence evaluation), or the outcome of a concept being activated (outcome of activation; Dudscig et al., 2015). Helping to clarify this issue, de la Vega et al. (2012; 2013) found the valence evaluation phase to be important when triggering the valence-space effects, and Meier and Robinson (2004) found a unidirectional relation with valence evaluations activating spatial metaphors, rather than vice versa. This highlights that valence evaluation is a critical aspect of this effect.

As the available literature exploring this relation has focused on word processing, we aim to explore the valence evaluation mechanism relating to other stimuli, namely emoji. Emoji present an interesting case as these denote emotion states (e.g., happy, sad) rather than being emotion-laden (e.g., victory, disease). As such, the valence evaluation process here may operate differently compared to linguistic evaluation as is the case for word stimuli. This may help further elucidate the mechanism underpinning how spatial processing is associated with emotion concepts, specifically at the valence evaluation phase of processing. Emoji provide an ideal test case as, much like words, they can be viewed in printed format and are often used in written communication. Given that spatial iconicity effects have been observed for words (e.g., "happiness" and "sadness"; Dudscig et al., 2015), it is of interest to determine whether this effect extends to other symbolic representations of emotions; specifically, emoji.

Whilst the majority of research has typically focused on word stimuli, other work has focused on facial processing which arguably may be more relevant to underpin expected effects of emoji processing. This has typically measured judgements relating to structural discriminations (face/non-face), recognition and gaze processing/direction, and sought to test effects from factors such as spatial frequency of stimuli (Beffara et al., 2015), holistic versus featural processing (Beaudry et al., 2014), facial inversion (Tanaka et al., 2022), eye contact (Cañadas & Lupiáñez, 2012), time course of repetition (Bentin & Moscovitch, 1988), visual field asymmetries (Hagenbeek & Van Strien, 2002) and emotional facial expression (Pazderski & McBride, 2018). For example, modified spatial stroop tasks have been used to explore mechanisms of gaze processing from faces (Cañadas & Lupiáñez, 2012), and noted that effects here may be modulated by facial expressions (Jones, 2015; Marotta et al., 2022). That is happy and angry faces have been found to elicit stronger effects than neutral ones (Jones, 2015; Marotta et al., 2022). Other research has noted that facial recognition performance shows a positive expression advantage, in which faces with happy expressions are more accurately recognised compared to angry or fearful faces (D'Argembeau & Van der Linden, 2011; Tanaka et al., 2022). In respect the influence of spatial position on processing non-word stimuli (e.g., symbolic objects, faces), research notes the relevance of semantic congruence (Banks et al., 1975). That is, stimuli are typically judged more efficiently when placed in a spatial position which is congruent to their location in the physical world (ibid). Specifically for faces which depict positive and negative emotion, research has found most efficient responding when the faces depict intense extremities of emotion and when these are spatially congruent to conceptual representations of emotional valence (left = negative, right = positive) (Baldassi et al., 2021, 2023; Fantoni et al., 2019). However, no research to date has explored whether spatial iconicity effects exist for facial stimuli on the vertical plane, which align to the observed emotion-space effects which have been found for emotionally-valenced words (Meier & Robinson, 2004). Similarly, this presents an intriguing notion for emoji. As noted previously, although emoji are often assumed to be emotional stimuli based on how we report that we use them (Kaye et al., 2016), these do not necessarily show to be processed emotionally by receivers (Kaye et al., 2021, 2023). Utilising paradigms common to spatial iconicity research (e.g., the Spatial Stroop), provides an interesting way to determine whether we process emoji emotionally in a way that is comparable to their valence-equivalent emotion words (i.e., happy = up, sad = down).

This formed the basis for the current study in which we explored spatial iconicity effects of emoji based on their vertical positioning. There is currently a paucity of research specific to emoji in this regard, with only one previous study which has explored this (Kaye et al., 2022), but in respect of obtaining explicit valence evaluations of emoji rather than implicit behavioural measures (reaction times, etc). Whilst this has observed spatial congruence effects (in which positive emoji were rated significantly more positively when in upper space, and negative emoji more negatively when in lower space, relative to other conditions), it is not possible to determine the phase at which spatial processing is associated with emotion conceptualisation: stimuli processing, valence evaluation, or outcome of activation. As such, by using a spatial stroop paradigm with implicit responding measures, the current study was better equipped to identify any early stage at which spatial processing is primed by the valence of emoji.

In summary, we aimed to ascertain the extent to which implicit valence evaluations of emoji in valence-congruent vertical positions influence valence-space effects. Within this, we specifically addressed the following research question (RQ) and hypotheses:

RQ1. Does the vertical positioning of emoji presentation impact on accuracy and latency of valence evaluations?

H1. Congruent emoji and vertical positioning pairings (happy emoji + upper positioning; sad emoji + lower positioning) will be responded to more accurately than incongruent pairings and control conditions.

H2. Congruent emoji and vertical positioning pairings (happy emoji + upper positioning; sad emoji + lower positioning) will be responded to more quickly than incongruent pairings and control conditions.

These research questions are important to help understand aspects of earlier-stage processing of emoji to better identify the extent to which they may be implicitly processed as emotion concepts.

2. Method

2.1. Transparency and openness

We followed a number of procedures regarding transparency and openness in our research. This includes making our protocol, stimuli and data available via OSF (links included in the respective sections of this report).

2.2. Design

We used a 2 (emoji valence: positive, negative) x 3 (vertical position: upper, lower, central) within-participants design. Emoji were presented across three conditions: 1) congruent (i.e., positive emoji in the upper vertical space; negative emoji in the lower vertical space); 2) incongruent (e.g., positive emoji in lower vertical space; negative emoji in upper vertical space); and 3) control (e.g., positive and negative emoji in the central visual space).[2]

2.3. Participants

Prior to the research being conducted, it received full ethical approval from the Department of Psychology Research Ethics Committee at Edge Hill University. Opportunity sampling was undertaken from the host institution as well as partner ones. . The final sample ($N = 87$) had an average age of 19.64 years ($SD = 1.87$; range = 18–28 years), with a gender breakdown of 15 males, 71 females, and 1 non-binary. Recent studies report very large effects of congruence when using various types of Spatial Stroop tasks. Eliciting, for example, effect sizes of partial eta squared of 0.69 (Schneider, 2020) to partial eta squared of 0.88 (Tafuro et al., 2019). We performed a sample calculation using the package WebPower (Zhang et al., 2018, p. 72) in R using a more typical large effect size of a Cohen f of 0.4, and power of 0.8. A sample of 81 participants would be required to achieve this effect size using a standard 2 × 3 repeated measures ANOVA design.

2.4. Measures and stimuli

2.4.1. Pre-test mood

Prior to the main task, we obtained a pre-test measure of current mood to identify if our sample displayed excessive levels of either positive or negative mood. For this, we used the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). This consists of 20 adjectives of which 10 denote positive affect (e.g., alert, excited) and 10 represent negative affect (e.g., distressed, upset). This is rated on a 5-point Likert scale, in which participants endorse the extent to which the adjectives represent their current mood (1 = very slightly or not at all, 5 = extremely). Cronbach's alpha for the Positive and Negative subscales were found to be acceptable ($\alpha = 0.90$ and $\alpha = 0.90$ respectively). We calculated total scores overall and per sub-scale for use in the subsequent analyses. A larger score on the Positive Mood subscale suggests a more positive affect, and a larger score on the Negative Mood subscale suggests a more negative affect. Scores for the Positive Mood subscale were within a typical range where the average score (out of 50) was 25.10 ($SD = 8.22$, Skew = 0.23, Kurtosis = 2.12), suggesting there was no evidence the sample had an extreme positive affect. Similarly, the average score for the Negative Mood subscale was 15.30 ($SD = 6.38$, Skew = 1.78, Kurtosis = 5.87) suggesting there was no evidence the sample had a negative affect. Taken together, this suggests our sample was generally positive in affect, but not to any particular extreme. As such, we did not include this as a covariate in our main analyses.[3]

[2] We also used neutral emoji across the three vertical positions too for experimental control, but these do not feature in the experimental design regarding spatial congruence.

[3] For full transparency, including positive and negative affect as covariates in the statistical model for both accuracy and latency has negligible effects (around 0.0002 difference to any value).

2.4.2. Emoji Spatial Stroop Task

The Emoji Spatial Stroop was originally created by Kaye et al. (2022), and we modified this for the purposes of conducting a reaction time study. Specifically, the emoji stimuli remained equivalent in that we used the same positive, negative and neutral emoji (24 in total; 8 per emoji valence) which were originally chosen from the stimuli rated in Rodrigues et al. (2018). As such, the emoji selected represented positive, neutral and negative valence conditions respectively. Therefore, of the 24 total emoji stimuli used, there were eight emoji per emoji valence condition. See Appendix 1 for emoji stimuli.

In respect of stimuli presentation for vertical positioning, this used the stimuli originally created by Kaye et al. (2022). Specifically, each emoji was positioned within a vertical rectangular box to denote upper, lower or central positioning. All emoji (formatted to display as 3.8 cm × 3.8 cm) were positioned on the central vertical line of the box, with the vertical positions. This was developed on a PC of screen size 1920 mm × 1080 mm and whilst presentation per participant was dependent on their screen size, stimuli presentation would be adjusted using a ratio-effect.

In the upper vertical positioning condition, emoji were placed between 0.5 and 0.7 cm below the top line of the rectangle. In the lower vertical positioning condition, they were placed between 0.5 and 0.7 cm above the base of the rectangle. In the control condition, they were placed in the centre. Each stimuli image (i.e., trial) was saved as an individual PNG file and uploaded into the Gorilla software. The following Open Science Framework link provides a copy of the Emoji Spatial Stroop task and individual stimuli PNG files https://osf.io/jk8qc/?view_only=432c2fae02c04e77966692c5a393edd3 To ensure the presentation of stimuli remained equivalent across the sample, participants were requested to complete the study on a PC rather than a mobile or other device (Gorilla software incorporates a function which blocks tablet or mobile devices when this is specified as an exclusion criterion within the recruitment set-up).

2.5. Procedure

The study took place on-site, whereby participants were invited to a Psychology laboratory to undertake the research. Data were collected between January and May 2022. The online link to the research study hosted on Gorilla Experiment Builder (Anwyl-Irvine et al., 2020) was set up on a PC in a quiet lab room[4]. Participants were invited to commence the study by providing demographics (age, gender) and then completing a measure of current mood (PANAS, Watson et al., 1988). Next, participants undertook the Emoji Spatial Stroop Task. Prior to the first block, a practice block of four trials was conducted to help familiarise participants with the format of the task and give feedback on accuracy of trials.

Overall, there were 144 trials, contained in four blocks each containing 36 trials. Block 1 and 3 asked participants to respond to the question "Is this happy?" and Block 2 and 4 to respond to "Is this sad?". Trials consisted of 8 positive emoji stimuli x 3 positions (24 trials), 8 negative emoji stimuli x 3 positions (24 trials), and 8 neutral emoji stimuli x 3 positions (24 trials). The order of blocks and trials was randomised in the experimental software. Across the experiment, each stimulus per position was also presented twice, to counterbalance the response key used to issue a response.

For each trial, a central fixation cross was displayed for 500ms. This was followed by a screen displaying text with the question "Is this happy?" or "Is this sad?" for 500ms. Next, the stimulus (emoji + vertical position) was presented. Participants responded using the "s" and "k" for "Yes" or "No" which was counterbalanced equally across the four blocks. This stayed on the screen until a response was recorded or timed out if no response was forthcoming within 5000ms. Within this, participants were instructed to respond as quickly and accurately as possible. Response time (RT in ms) and accuracy (ACC) were recorded for each trial. RT was calculated based on the time difference from the time recorded at which the stimuli first appeared on screen and the response key was pressed. Once they had completed the Emoji Spatial Stroop task, participants were debriefed and thanked for their time. The whole study took approximately 20 min to complete.

[4] This was run on-site but data were collected via the online software. We chose to this in this way, rather than fully remotely to issue a greater level of experimental control and to use the opportunity to connect directly with participants regarding any feedback on the study for the purposes of improving our future research in this area.

3. Analytic strategy

Accuracy and response times to correct trials were analysed using mixed effects modelling. A benefit of using linear mixed effects or binary logistical modelling over more traditional factorial ANOVAs is that ANOVAs do not account for variability across participants and stimuli (trials) which can inflate Type 1 Error. As such these modelling techniques can treat this potential variability as random effects in the model. Linear mixed effects modelling was used where data are continuous (response times) and binary logistic modelling was used where data were discrete (accuracy; 1,0). All models were fitted using the package lme4 in R (Bates et al., 2015). Models were developed in order of complexity from a null model (a model with a constant in place of fixed effects), to main effects and then interaction models. p values were generated by comparing models to each other using likelihood ratio tests.

4. Results

All data and scripts are available on the following Open Science Framework page: https://osf.io/u54xm/?view_only=272f3a462c874cf38cc7be8664e045a1. Descriptive analyses on the study variables were conducted. Table 1 shows the mean and standard deviations for accuracy and latency by experimental condition.

Accuracy was determined at trial level based on whether participants correctly responded to the question "Is this happy?" For trials with positively-valenced emoji, a response was recorded as correct if participants indicated "Yes", and for the negatively-valenced emoji trials, if they responded "No". The converse applied to trials which included the question "Is this sad?". Positive and negative trials were combined. Responses were modelled in a 2 × 3 mixed effects model with emoji valence (positive, negative) and spatial congruency (congruent, control, incongruent) entered as fixed effects, and Stimuli Image and Participant ID entered as random effects. Trials were excluded if response times were below the typical processing speed threshold of 200ms (Whelan, 2008) or if they exceeded 2000ms. The latter was identified in line with other research (e.g., Siakaluk et al., 2016) where any response larger than 2000ms is likely not a genuine response to the task. In total, 8.92% trials were excluded across all participants.

Neither the main effects models (Emoji: G^2 (1) = 2.55, p = 0.11; Emoji + Spatial Congruency: G^2 (2) = 1.92, p = 0.38) or the interaction model (G^2 (2) = 2.78, p = 0.25) fitted the data better than a null model. This indicated that there was neither a main effect of emoji valence or spatial congruency on accuracy nor an interaction between them. The predicted accuracy as modelled by the regression can be viewed in Fig. 1.

To explore emoji valence and spatial congruency on latency, response times were recorded as the duration between emoji stimuli onset and when the participant pressed either the "k" ("No") or "s" ("Yes") key. Given the typical skew of response time data, log transformed response times were used in the analyses. Responses were modelled in a 2 × 3 mixed effects model with emoji valence (positive, negative) and spatial congruency (congruent, control, incongruent) entered as fixed effects, and Stimuli Image and Participant ID entered as

Table 1
Descriptive Analysis of Accuracy and Latency (in ms) between Experimental Conditions.[1]

Emoji Valence	Experimental Condition	Accuracy (% correct)			Latency (in ms)		
		M (SD)	Skewness	Kurtosis	M (SD)	Skewness	Kurtosis
Positive	Congruent (Upper)	87 (34)	−2.15	5.63	816 (310)	1.38	4.72
	Incongruent (Lower)	81 (39)	−1.58	3.51	823 (329)	1.33	4.26
	Control (Central)	88 (33)	−2.33	6.43	781 (297)	1.72	6.27
Negative	Congruent (Lower)	82 (38)	−1.70	3.88	860 (286)	1.31	4.97
	Incongruent (Upper)	82 (39)	−1.64	3.70	844 (308)	1.36	4.79
	Control (Central)	83 (38)	−1.76	4.11	820 (295)	1.36	5.00
Neutral	Control[5]	78 (42)	−1.32	2.75	859 (326)	1.17	4.11

random effects. Trials were excluded if the duration was more than 2000ms and less than 200ms. Only trials recorded as being correct were used in the analyses. In total, 6.92% of trials were excluded across all participants.

Neither the main effects models (Emoji: χ^2 (1) = 1.25, p = 0.26; Emoji + Spatial Congruency: χ^2 (2) = 2.27, p = 0.32) or the interaction model (χ^2 (2) = 0.12, p = 0.95) fitted the data better than a null model, indicating that there was no main effect of emoji valence or spatial congruency on response times to correct identification or an interaction between them. Response time data can be viewed in Fig. 2.

5. Discussion

Despite emoji often being assumed to be emotional, the empirical literature which explores receiver processing of emoji stimuli has not been forthcoming in supporting this assertion. Given the popularity and prevalence of emoji in 21st century text-based communication, it is pertinent to consider whether these emotion symbols are processed equivalently to other emotion or emotion-laden stimuli. As such, we aimed to establish the extent to which (implicit) valence evaluations of emoji in valence-congruent vertical positions influenced valence-space effects.

The effects of spatial iconicity on stimuli processing have been studied extensively within cognitive science (e.g., Zwaan & Yaxley, 2003). This effect has often been observed for emotion concepts, finding processing advantages of stimuli presented in the valence-congruent vertical positions (e.g., happy in upper space, sad in lower space). As reviewed in the introduction, the majority of this work has focused on word stimuli, with less testing these effects on other emotion stimuli (e.g., faces or emoji). As such, we situate our research within this broader field to establish the extent to which these effects apply to emoji stimuli in order to address the central question: "are emoji emotional?" Of course, a caveat of this is that our insights are somewhat restricted to the laboratory context and thus are not studied in the context of everyday online communication. However, as is that case with much cognitive science evidence, we argue there is merit to understanding the mechanisms and processes of a given phenomenon within a controlled setting, to better understand how this may operate on a fundamental level, prior to testing in a real world scenario. Or alternatively, our findings may provide part of the evidence for how processing may differ in laboratory versus real world contexts. The following sections outline our main findings and implications in this regard.

Overall, our findings do not provide evidence that spatial iconicity interacts with processing of emoji via implicit responding. That is, we did not find significant effects, or interaction effects of vertical positioning of emoji presentation on accuracy or latency of responses. Specifically, congruent emoji and vertical positioning pairings did not elicit significantly more accurate (H1) or faster (H2) responses than incongruent pairings and control conditions. As such, both hypotheses 1 and 2 are refuted.

From a theoretical perspective, there are a number of interesting possibilities for our null findings and discrepancies with previous research (e.g., Kaye et al., 2022; Meier & Robinson, 2004). Our null findings may suggest that at least when recording implicit responses, emoji are not processed as emotion concepts. Conversely, previous findings have evidenced spatial congruence effects of emoji by vertical positioning (Kaye et al., 2022). However, these discrepant findings may reside from the fact that this previous work measured explicit evaluations (perceptions via a Likert scale) rather than via an implicit response

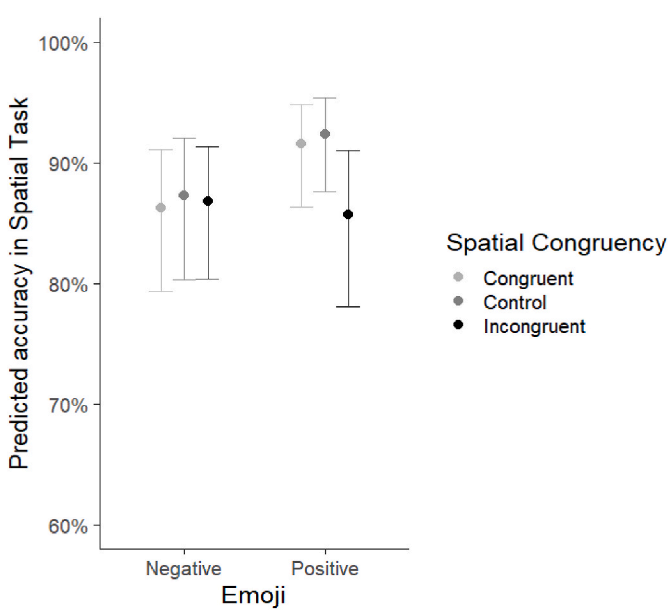


Fig. 1. Upper and lower confidence intervals for modelled predicted performance in emoji categorisation task (emoji valence by spatial congruency).

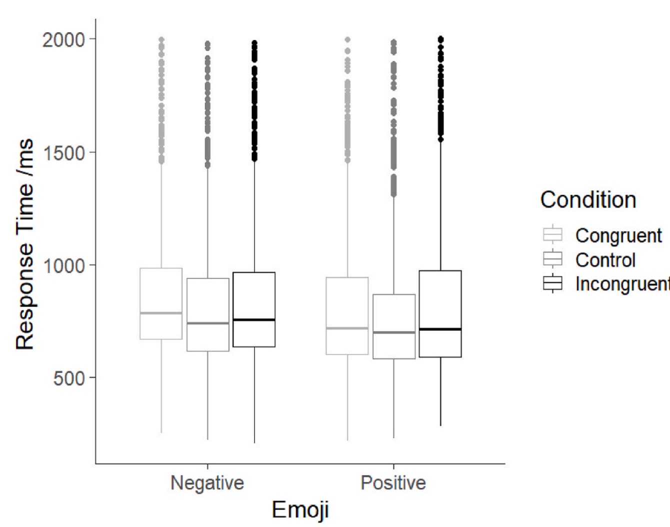


Fig. 2. Response times to correctly identify emoji valence (valence by spatial congruency). Data show range, median and interquartile ranges.

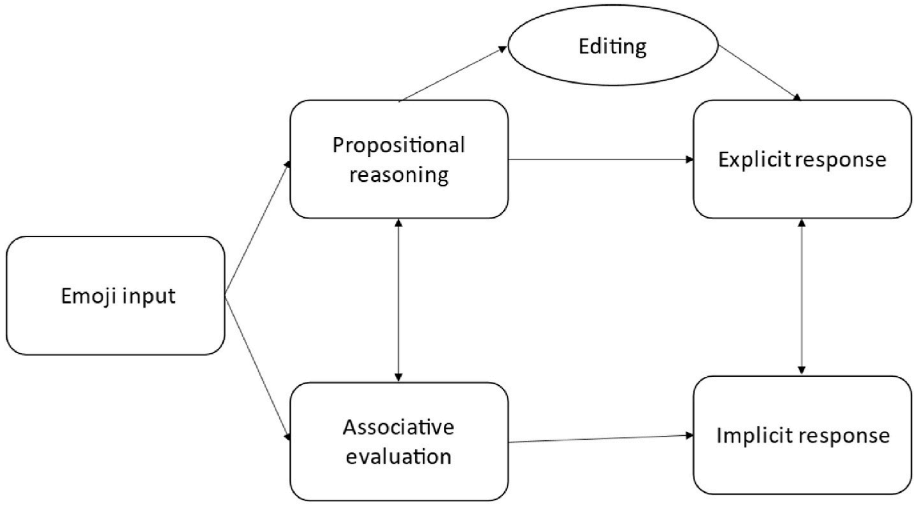


Fig. 3. The Associative-Propositional Evaluation Model (modified to apply this to Emoji Valence Evaluations).

format. This may suggest that emoji are processed at later stage rather than early-stage processing (Kahneman, 2011), and as such any effects only become evident in measures which are inclusive of a deliberative, conscious process rather than an automatic one. This proposition would appear to align with other recent findings in this field (Kaye et al., 2021, 2023), and thus adds weight to the argument that emoji may be better considered as social communicational tools rather than symbolic emotion concepts. In relation to the theoretical discussions about how spatial processing is associated with the various stages of stimuli processing (de la Vega et al., 2012, 2013), we focused on the valence evaluation phase. This could help establish whether the unidirectional relation of valence evaluations activating spatial metaphors as found in word processing (Meier & Robinson, 2004) also applies to emoji. In this case, our null findings indicate that there is no evidence of activation of spatial metaphors through the valence evaluation process, at least not captured through our implicit response format.

As such, it may be that an embodied cognition perspective is less relevant as a theoretical basis, and instead we may be better placed to understand the distinct automatic (fast) versus deliberate (slow) processing of emoji using parallel processing models such as the Associative-Propositional Evaluation model Gawronski & Bodenhausen, 2006; 2007). Specifically, the fact that research testing affective processing of emoji to date has found effects on explicit responding, but not implicit responding, is suggestive that this may operate through a propositional reasoning pathway rather than an associative evaluation pathway (see Fig. 3 for visualisation). Put another way, emoji may not be encoded as emotion concepts, but instead valence evaluations are activated based on considered, logical reasoning (Gawronski & Bodenhausen, 2011). Perhaps the propositional element of reasoning here involves retrieval of conceptual knowledge from considering the contexts in which these types of emoji tend to be used, from which to make a valence evaluation. This would support previous claims suggesting that interpreting emoji may be a more considered, rather than automatic process (Kaye et al., 2016). In this sense, we may argue that the associative evaluation pathway does not appear to play an active function in emoji processing, at least based on available evidence in the existing literature. This requires further empirical testing but to our knowledge, no previous work in this field has specifically proposed how different processing pathways may apply differentially to emoji valence evaluations.

As with all research, this study is not without its limitations. Firstly, categorisation tasks which typically use word stimuli, studies tend to ask questions such as “Is this a word?” or “Is this concrete?“, largely to reduce the likelihood of semantic priming (Heyman et al., 2015; Neely et al., 1989). In the case of emoji, establishing suitable prompts is more challenging as emoji properties do not conform to a universal language system and so asking “Is this concrete?” does not have a universal correct response in the same way as words. Therefore, the prompts used in the current study may, to some extent, have inadvertently primed valence evaluations, although this would equally apply to all conditions so is unlikely to have had differential impacts here. As such, future research which tests different task instructions which may be more “implicit” so as not to ask explicitly about valence may be relevant to replicate these effects. Another alternative is to use tasks alongside measurements which can be considered inherently more “implicit” such as via eye-tracking or through the dot-probe task to ascertain any implicit attentional bias in this process (MacLeod et al., 1986). Further benefits of measures such as eye-tracking are that this could also identify the specific visual features of emoji (e.g., mouth, eyebrows) which might induce the emotional detection process through features such as emoji saliency, and could more rigorously test the effects of processing which may occur differentially in upper and lower visual fields (Hagenbeek & Van Stein, 2002). Whilst these were not something within the scope of the current study, we argue this has merit for further developing these insights.

Secondly, we focused exclusively on a small set of emoji which represented positive, negative and neutral valence. This provides a useful “litmus test” for answering our research questions, however it is not known the extent to which these findings may apply to the range of other emoji which are commercially available. Arguably, given we observed null effects for standard types of emoji such as “happy” and “sad” it is unlikely that more ambiguous or less familiar emoji would elicit more pronounced valence evaluation differences based on vertical positioning. Therefore, while we do not wish to generalise our findings to all emoji, we suggest that these were a suitable basis as a first test of these ideas. However, future studies could certainly extend these findings to establish the extent to which spatial iconicity may operate for emoji which vary in valence as well as other dimensions (arousal, dominance, etc).

Third, our sample size was relatively small and might be attributable to our null findings. However, it is relevant to note that previous studies which find large effects have used much smaller sample sizes (Schneider, 2020; Tafuro et al., 2019), and so this might warrant further consideration of what is considered optimal for research of this nature. Other

[5] Given the experimental design does not have congruent vs incongruent vertical positioning for neutral emoji, this emoji condition operated fully as a single control and responses for all vertical positioning conditions were combined as one vertical positioning control condition.

considerations relating to our null results might be due to behavioural tasks not being sufficiently sensitive to capture any potential sensory prediction errors or similar which might be experienced in valence-incongruent vertical positions. Previous research for example has evidenced that behavioural measures might not elicit significant differences between semantically congruent and incongruent emoji-word pairs, whilst electrophysiological measures do (Yang, Yang, Xiu, & Yu, 2022). As such, null results might be considered with this is mind.

Finally, other future work might consider receiver processing when this is more specifically contextually-bound. That is, we studied processing in isolation of context, but it is conceivable that there may be contextual effects which may assist the processing efficiency of emoji processing via capitalising on top-down resources. When emoji are presented in student feedback, as one example of a specific context, there may be specific expectations which interact within the processing cycle and thus may facilitate (or interfere) with processing efficacy. Testing the bottom-up versus top-down factors here which may be derived through more specific choice of context could therefore be a useful extension of this work.

6. Conclusion

To our knowledge, we provide the first empirical evidence examining spatial iconicity on valence evaluations of emoji, measured by implicit responses. Despite previous findings reporting such effects at an explicit reporting level, our findings do not corroborate the effects. Namely, we suggest that emoji may be more representative of later rather than early-stage processing and therefore may be more likely to be processed through propositional reasoning rather than be encoded implicitly as emotion concepts. Future research, however, is needed to see whether these findings are echoed when assessing implicit processing using other methodological approaches or when assessing this outside of the laboratory setting. Overall, our findings suggest that for emoji receivers, these are not serving an emotional function on an implicit level, so it may be the case that these require more deliberate processing and/or be situated in sentiment-contingent contexts (e.g., positive text on social media posts, etc) to serve as emotion symbols for receivers.

CRediT authorship contribution statement

Linda K. Kaye: Conceptualization, Methodology, Validation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Andrew K. MacKenzie:** Software, Formal analysis, Resources, Data curation, Writing – review & editing, Visualization. **Sara Rodriguez-Cuadrado:** Conceptualization, Methodology, Writing – review & editing. **Stephanie A. Malone:** Conceptualization, Methodology, Writing – review & editing. **Jemaine E. Stacey:** Software, Resources, Writing – review & editing. **Ella Garrot:** Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

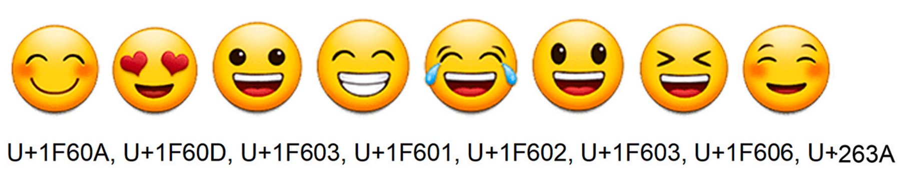
Data availability

Data links are explicitly signposted in the manscript

Appendix 1. Emoji stimuli

Below are the emoji used to represent the three valence conditions. These are taken from the Unicode Emoji Chart which is accessible here: http://unicode.org/emoji/charts/full-emoji-list.html. We used emoji from the Samsung platform column in all cases. The specific code per emoji is listed chronologically underneath each icon.

Positive valence (high valence)



Neutral valence (moderate valence)

Negative valence (low valence)

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