

RUNNING HEAD: WHEN LINES & SHAPES COMMUNICATE EMOTIONS

**Simple lines and shapes are associated with,  
and communicate, distinct emotions**

Alejandro Salgado-Montejo<sup>1,2</sup>, [alejandro.salgado@psy.ox.ac.uk](mailto:alejandro.salgado@psy.ox.ac.uk), TEL: +44 1865 271364

Carlos José Salgado<sup>2</sup>, [carlos.salgado2@unisabana.edu.co](mailto:carlos.salgado2@unisabana.edu.co), TEL: +57 1 8615555 ext. 21017

Jorge Alvarado<sup>3</sup>, [jorge.alvarado@javeriana.edu.co](mailto:jorge.alvarado@javeriana.edu.co), TEL: +57 1 3208320 ext. 5301

Charles Spence<sup>1</sup>, [charles.spence@psy.ox.ac.uk](mailto:charles.spence@psy.ox.ac.uk), TEL: +44 1865 271364

<sup>1</sup> *Crossmodal Research Laboratory, Department of  
Experimental Psychology, University of Oxford, Oxford, UK, OX1 3UD*

<sup>2</sup> *Universidad de La Sabana, Km. 7, Autopista Norte de Bogotá, Chía, Colombia*

<sup>3</sup> *Industrial Engineering Department, Pontificia Universidad  
Javeriana, Carrera 7 No. 40-62, Bogotá Colombia*

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CORRESPONDENCE TO: Alejandro Salgado-Montejo, Department of Experimental  
Psychology, University of Oxford, Oxford OX1 3UD, UK; E-MAIL:

[alejandro.salgado@psy.ox.ac.uk](mailto:alejandro.salgado@psy.ox.ac.uk), TEL: +44 1865 271307; FAX: +44 1865 310447.

## ABSTRACT

We investigated whether lines and shapes that present face-like features are associated with emotions. In Experiment 1, participants associated concave, convex, or straight lines with the words happy or sad. Participants found it easiest to associate the concave line with happy and the convex line with sad. In Experiment 2, participants rated (valence, pleasantness, liking, and tension) and categorized (valence and emotion words) two convex and concave lines that were paired with 6 distinct pairs of eyes. The presence of eyes affected participants' ratings and response latencies. In Experiment 3, we examined whether dots that resembled eyes would be associated with emotional words. The participants found it easier to match certain sets of dots with specific emotions. The results suggest that facial gestures associated with specific emotions can be captured using relatively simple shapes and lines.

**KEYWORDS:** visual cue, emoticon, face, emotion, embodied

There has been long-standing interest, from both psychology and neuroscience, in trying to understand how the brain detects specific sensory patterns and elicit motivational and affective states (Gordon, 1909; Lorenz, 1935; Tinbergen, 1948). Pattern detection, for example, allows an organism to recognise threat-related situations (e.g., a predator or a harmful gradient change in the air or water), as well as to identify food or potential mates (Ewert, 1987).

Research carried out over the last century or so shows that simple visual features can convey a specific valence (Gordon, 1909; Lundholm, 1921; Lyman, 1979; Poffenberger & Barrows, 1924, see also Hair, 1995/1996). Several potential explanations have been put forward over the years to account for how certain visual features are associated with a specific valence. For instance, Bassili (1978) used point-light sources (a technique initially developed by Johansson, 1973) to study the geometric patterns of facial expressions of emotion. This research opened up the door to the possibility that the face conveys emotion via low-level features that are inherent to distinct facial expressions of emotion<sup>1</sup>. Moreover, Aronoff, Barclay, and Stevenson (1988), conducted a cross-cultural study in which associations were found between roundness and happy expressions and between angular/diagonal shapes (i.e., a “V”) and angry faces. There is also evidence demonstrating that certain facial expressions can be classified as more angular or rounded, and that this is consistent with their emotional valence (Aronoff, 2006; Marsh, Adams, & Kleck, 2005a; Zebrowitz, 1997; see also Aronoff, Woike, & Hayam, 1992).

The above research has also motivated those studies showing that simple visual stimuli (i.e., a “V” or downward-pointing triangle), that emulate the eyebrows of an angry facial expression, can communicate valence without the need for other cues to be present (Larson, Aronoff, Sarinopoulos, & Zhu, 2009; Larson, Aronoff, & Stearns, 2007; Watson, Balgrove, Evans, & Moore, 2012; Watson, Balgrove, & Selwood, 2011; but see Tipples, Atkinson, & Young,

2002)<sup>2</sup>. The saliency of the eyebrows and of eyebrow-like shapes in conveying anger is further supported by research from Lundqvist, Esteves, and Öhman (1999). Lundqvist et al. demonstrated that the eyebrows facilitate the categorization of faces as threatening or not (cf. Lundqvist, Esteves, & Öhman, 2004). Furthermore, there is evidence to suggest that the brain possesses specific neural circuits that identify threatening stimuli, even in the absence of a facial feature (Öhman & Mineka, 2001). According to LoBue (2014), for instance, simple visual stimuli that are not associated with a facial gesture can be associated with threat; specifically lines that resemble a snake.

Another approach seeking to explain how simple visual stimuli can be associated with a specific valence comes from research carried out by Bar and Neta (2006, see also Silvia & Barona, 2008). After presenting participants with a wide variety of objects varying in their angularity and roundness, these researchers documented an overall preference for roundness. Very recently, Roca, Gómez-Puerto, Nadal, and Call (2015) have provided evidence that the preference for rounder visual objects extends to other primates species. Intriguingly, Bertamini, Palumbo, Gheorghes, and Galatsidas (2015) have argued that the effect may perhaps be mediated by a dislike for angularity. In addition, researchers interested in visual aesthetics have shown that a wide range of visual features can influence visual preference. For instance, there is evidence that bilateral symmetry, fewer elements, and balance can have an influence on the preference (and hence on the associated valence) of a stimulus (see Palmer, Schloss, & Sammartino, 2013, for a review).

So far, a large body of research has addressed how simple lines and shapes convey valence. However, the majority of the studies that have been published to date have focused on a specific emotion and/or stance (i.e., anger and threat). In order to study this emotion/stance, two key shapes (derived from the same facial gesture) have been proposed: A “V” and a downward-pointing triangle (see Watson et al., 2012). For this reason, we decided to extend

the research conducted thus far, to incorporate simple visual stimuli that convey other emotions than simply just anger or threat. Accordingly, we developed a series of three experiments seeking to evaluate whether concave and convex lines by themselves and paired with eye-like shapes could be matched with a specific valence. We also wanted to assess whether eye-like dots would be associated with specific emotions.

We expected that the participants would find it easier to associate the concave line with the word “happy” and the convex shape to the word “sad” (Experiment 1). We also predicted that the eye-like shapes would influence the perceived valence of an emoticon (schematic face) (Experiment 2). Finally, we anticipated that the eye-like dots could be matched to specific emotions (Experiment 3). In the first two experiments, incongruent visual arrangements (e.g., a concave line with a set of oblique dots) and/or pairings of lines with words conveying an opposite valence were expected to be more difficult to match to a specific word (i.e., valence or emotion). We also predicted that incongruent stimuli would yield slower reaction times (RTs). Furthermore, it was expected that, during Experiment 3, the participants could match eye-like dots to specific emotions, according to their resemblance to specific facial gestures. In line with the latter prediction, we also anticipated that those stimuli that had not been derived from facial gestures would be harder to match with a specific emotion (Experiment 3). A better understanding of how simple visual shapes and lines communicate emotion further links those studies related to pattern detection with emotion theory.

## EXPERIMENT 1

### Methods

*Participants:* Fifty-four participants (24 from the UK and 30 from Colombia, 29 females,  $M_{age} = 26.3$  years,  $SD_{age} = 4.3$ ,  $range_{age} = 19-37$  years) volunteered to take part in the

experiment. They were invited to participate in the study via the database of the Crossmodal Research Lab and of the Universidad de La Sabana. All of the participants signed a standard consent form; the experiment was reviewed and approved by the Central University Research Ethics Committee at the University of Oxford and by the Research Commission of the International School of Economics and Business Science at Universidad de La Sabana, Chía, Colombia. The experiment took approximately 45 minutes to complete, and individuals received either £5 or academic credit in return for their participation. Sampling procedures, informed consent, and payment was the same in all of the experiments reported here.

*Apparatus and materials:* E-Prime 2.0 software (Psychology Software Tools, Inc.) was used to present the stimuli, and record the participants' responses. The participants sat in front of a 14" 1024x768 pixels LED monitor, with a screen refresh rate of 60 Hz. Adobe Illustrator CS6 was used to create the three distinct lines (concave, convex, and straight) and the same lines together with two dots that resembled a pair of eyes (see Figure 1A). A modified version of the implicit association test (IAT) was used to evaluate the strength of the association between the convex and concave lines and two different valence words (Sriram & Greenwald, 2009, also see Greenwald, McGhee, & Schwartz, 1998; Larson, Aronoff, & Steuer, 2012).

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INSERT FIGURE 1 ABOUT HERE

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*Procedure:* Six IATs (three included the “lines without eyes” and the other three included the “lines with eyes”) were presented to the participants. The order of stimulus presentation was counterbalanced across participants. Each IAT included two putatively congruent and

incongruent conditions in which the participants had to associate the stimuli with the words happy (left mouse key) or sad (right mouse key). We followed Sriram and Greenwald's (2009) abbreviated version of the IAT here (see Table 1), [which reduces the task from seven stages down to four \(two congruent and two incongruent\)](#). Note though that [we](#) did not swap the response keys in stages 4 and 6 since our main interest was in determining whether the lines presented to participants could be associated with a particular valence, and if participants performed better when a particular line was paired with a specific word. Within each of the conditions (with or without eyes), each of the IATs (concave-convex, concave-straight, and straight-convex) was presented at random. There were 20 trials per stage. There were two congruent stages and two incongruent stages thus giving rise to a total of 80 trials (see Table 1). The two conditions ("without eyes" and "with eyes") were counterbalanced across participants. The stimuli were presented for 2500ms and a screen displaying the words "incorrect", "correct", and "too slow" were presented depending on the response given by participants in order to provide feedback.

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INSERT TABLE 1 ABOUT HERE

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The participants were informed that they would be presented with simple lines and with simple lines together with dots that resembled emoticons and that they should pair a line or emoticon with particular word (either happy or sad).

*Data analysis:* SPSS 22 (Armonk, NY: IBM Corp.) was used to analyse the data. Data analysis was performed following the procedure suggested by Greenwald, Nosek, and Banaji (2003). The mean RT for each [of the four](#) stages was calculated, as well as the inclusive standard deviation for stages [1 and 3, and 2 and 4](#) (see Table 1). Next, the mean difference

between each pair of stages (1 and 3, and 2 and 4) was computed and divided by its standard deviation. The D measure was then determined by averaging the two resulting ratios. The mean of the correct responses for each stage plus 600ms was added to each RT when the participants chose the wrong association between the word and the line (see Cai, Sriram, Greenwald, & McFarland, 2004). Individual D measures per participant were also calculated. The aforementioned process was repeated for each of the IATs presented to the participants (see Table 1). A repeated measures Analysis of Variance (ANOVA) was performed with the IATs (concave-convex, concave-straight, and straight-convex) and the presence/absence of eyes as factors.

## Results

The D measures present medium effect sizes in the concave-convex and concave-straight IATs, with the “without eyes” condition displaying higher scores (see Cohen, 1988, 1992, for literature concerning how to interpret effect sizes, but see also Rosenthal, Ronsow, & Rubin, 2000). This means that it was easier to associate the word happy with the concave line as compared to the convex line (without eyes  $D = 0.53$ ; with eyes  $D = 0.31$ ) and straight line (without eyes  $D = 0.51$ ; with eyes  $D = 0.46$ ), and to associate the word sad with the convex line. Furthermore, RTs were faster in the “no eyes” condition when compared to the “with eyes” condition. A slower RT suggests that more time is required to process the stimulus when the eyes are present. The analysis of the data revealed that there was a small effect size for the associations in the straight-convex IAT (without eyes  $D = -0.18$ ; with eyes  $D = -0.08$ ). Furthermore, in the straight-convex IAT, RTs were faster in the incongruent conditions as compared to the congruent condition (see Figure 2).

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Significant differences were found when calculating a D measure per participant and running a repeated measures ANOVA with the line (concave, convex, and straight) and the presence/absence of eyes as factors in order to compare the concave-convex, concave-straight, and straight-convex conditions. The line conditions also displayed significant differences,  $F(2, 31) = 44.53$ ,  $p < .001$ ,  $\eta p^2 = 0.59$ , thus showing that the participants found it easier to associate certain lines with the words happy or sad. Post hoc tests using Bonferroni correction revealed that the participants responded significantly **more rapidly** in the congruent phases, as compared to the incongruent phases, and in the concave-convex IAT when compared to the straight-convex IAT ( $M = 0.61$ ,  $SD = 0.07$ ,  $p < .05$ ). Pairwise comparisons also indicated significant differences when comparing the concave-straight and straight-convex IATs ( $M = 0.62$ ,  $SD = 0.08$ ,  $p < .05$ ). The latter result reveals that the concave-straight IAT gave rise to lower RTs in the congruent phase as compared to the incongruent stage. **Faster** RTs reflect **the fact** that the participants found it easier to match the concave line with the word happy and the convex line to the word sad when compared with the straight line. A significant interaction was observed between the eyes and the lines,  $F(1, 31) = 4.97$ ,  $p < .033$ ,  $\eta p^2 = 0.14$ , thus suggesting that particular configurations of the eyes and lines affected the speed of participants' categorization responses.

## Discussion

The results of Experiment 1 **support the suggestion** that simple visual elements such as lines can be associated with specific affective categories. **The present study also shows that the “no eyes” concave-convex IAT yielded the greatest differences in RTs when the congruent and incongruent phases were compared. The latter finding suggests that there is a greater valence contrast between the two lines (i.e., concave and convex) than when compared with the**

straight line. Overall, the participants responded more rapidly when they had to associate a concave line with the word happy as compared to when associating the same word with a convex or straight line instead. Our findings therefore contribute to the growing body of research showing that basic visual stimuli can be associated with a specific valence. They also expand the research by Larson et al. (2012), by testing stimuli other than a “V” and a downward-pointing triangle and demonstrate that simple visual stimuli can also be associated with a positive valence.

The results of Experiment 1 further demonstrate that people do not find it especially easy to categorize the word happy with the straight line even when the other option is the convex line, as revealed by the D scores. It is likely that the straight line can be associated with either a positive or negative valence depending on the other visual elements in a given display, in this case, the other line (concave or convex) that participants had to categorize in the IATs. Recently Salgado-Montejo et al. (2015) reported that a straight line embedded into product packaging could positively influence product liking, wanting, and purchase intent. Our results therefore suggest that factors other than emotional valence may explain why it is that a straight line can influence consumer behaviour. For example, it is possible that the location of the line with respect to other attributes that are also part of the label can influence product liking and purchase intent (see Berlyne, 1960, p. 244).

The observed interaction between the lines and the eyes, as well as the D scores presented in Experiment 1, reveal that the particular arrangements of the eyes and smile- or frown-like lines influence participants’ categorization performance. The influence of the eye-like shapes on RTs, however, presented a small effect size thus suggesting that the lines (i.e., concave, convex, and straight) were the main factor determining the valence of the stimuli.

Furthermore, it is unclear why the eyes had an effect on how easy it was to associate a line

with a specific valence. It is possible that dots that resemble eyes can also communicate a valence and therefore influence how an emoticon is matched to specific valence.

We thought it possible that gaining a better understanding of how different visual features present in a schematic face can influence the perceived valence could further clarify how emotions are processed and identified in the face. Hence, we conducted a second experiment designed to study the role of eye-like shapes in conveying a specific valence. The latter experiment would help determine some of the basic patterns present in a face that underlie a valence judgment.

## EXPERIMENT 2

In order to determine whether emoticons presenting different dots that resembled eyes could be rated and categorized in terms of different affective dimensions **we used** visual analogue (VA) scales and a forced choice task. The VA scales **were used to** measure participants' explicit ratings of each of the emoticons in terms of their emotional valence, pleasantness, liking, and tension. The forced choice task **provides** data **concerning** how easy it is to match a specific emotion with a **particular** valence (i.e., pleasant/unpleasant) or emotion (i.e., happy/sad).

The particular shape of the eyes (i.e., symmetrical, vertically or horizontally elongated, oblique, small, or big) might be expected to influence the particular emotion being, in some sense, communicated. Actually, this also happens when perceiving facial expressions of emotion. **That is, the** different facial muscles can communicate a particular emotion, or else the intensity of emotion, according to the specific combinations of facial movements involved (Cattaneo & Pavesi, 2014; Ekman & Friesen, 1978; Holstege, 2002).

## Methods

*Participants:* Twenty participants (11 females,  $M = 26$  years,  $SD = 3.46$ ,  $range = 19-32$  years) were recruited from the participant list of the Crossmodal Research Laboratory. The experiment lasted for approximately 25 minutes.

*Apparatus and materials:* E-Prime 2.0 software (Psychology Software Tools, Inc.) was used for the VA scales. Mouse tracking software (Freeman & Ambady, 2010) was used to assess performance in the forced choice task<sup>1</sup>. Adobe Illustrator CS6 was used to develop six different dots that resembled eyes and were paired with the concave and convex lines, respectively (see Figure 1B for the stimuli used). The stimulus display conditions were the same as [those used](#) in Experiment 1.

The different sets of dots that resembled eyes were designed taking into account the different facial muscles [around](#) the eyes, which are involved in communicating different emotions ([see Figure 3](#)). The other figures highlight a specific muscle and below the set of dots that more closely resembles the activation of that specific muscle. Dots that resemble sad (i.e., concave eyes, see Figure [3B](#)), joyful (Figure [3C](#)), surprised (Figure [3D](#)), and angry eyes (Figure [3E](#)) were developed. Two more sets of dots were presented to the participants, which do not match any of the activations of facial muscles proximal to the eyes (i.e., two small circles, see Figure [1C.4 and 1C.5](#)). These last sets of dots were used to determine whether it was easier to match specific emotion words to those dots that are associated with specific muscle patterns.

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<sup>1</sup> We had the intention of using mouse movements as complementary information to RTs, however we did not find significant results in this case and therefore do not report hand movement measures.

*Procedure:* VA scales were used to assess the emotional valence (anchored with the labels “sad” and “happy”), pleasantness (“unpleasant” and “pleasant”), liking (“not at all” and “extremely”), and perceived tension (“tense” vs. “relaxed”). The anchors for the pleasantness scales were derived from a study by Larson et al. (2012), in which the same words were used in an IAT. The liking scale was adapted from Finlayson, King, and Blundell (2007, see also Salgado-Montejo et al., 2015) and included the question “*How much would you like to experience the emotion displayed by the emoticon right now?*” The participants rated the twelve emoticons three times on the VA scales thus giving rise to a total of 36 trials. Each VA scale resulted in data that ranged from 0 and 100. The emoticons were presented once in the forced choice task. The order in which the VA scales and the forced-choice task were completed was counterbalanced across participants.

*Data analysis:* Participants’ responses on each of the VA scales were averaged. Repeated measures ANOVAs were performed in order to examine the participants’ responses to the VA scales. Pairwise comparisons with Bonferroni corrections were carried out to determine which of the VA scales presented the significant results. For the forced-choice tasks, a generalised estimating equations method (GEE) with a logistic regression model was carried out in order to analyse the participants’ choices. RTs were analysed using a GEE with a linear regression model (Hanley, Negassa, Edwardes, & Forrester, 2003; Salgado-Montejo, Alvarado, et al., 2015).

## Results

### *VA scales*

Participants’ responses on the VA scales were analysed using repeated measures ANOVAs with two factors (lines and eyes). There was a significant main effect with the lines (concave

vs. convex) as a factor, when comparing the mean scores of the emotion  $F(1, 19) = 476.67, p < .001, \eta^2 = 0.96$ , liking  $F(1, 19) = 371.43, p < .001, \eta^2 = 0.95$ , pleasure  $F(1, 19) = 346.77, p < .001, \eta^2 = 0.95$ , and tension  $F(1, 19) = 114.47, p < .001, \eta^2 = 0.86$  VA scales. The aforementioned results confirm the findings of Experiment 1, showing that a convex line can communicate a negative valence and a concave line a positive valence. A significant main effect was also found for the six eyes used in the study as factors when comparing the scores of the emotion  $F(5, 15) = 5.87, p < .01, \eta^2 = 0.66$ , liking  $F(5, 15) = 15.44, p < .001, \eta^2 = 0.84$ , pleasure  $F(5, 15) = 10.11, p < .001, \eta^2 = 0.77$ , and tension  $F(5, 15) = 26.19, p < .001, \eta^2 = 0.90$  VA scales. Overall, those eyes that were paired with the concave line were rated as more positive in all of the scales, with the opposite being true for those eyes paired with the convex line (see Table 2). Significant interactions were found between the lines and eyes in terms of the liking  $F(5, 15) = 13.74, p < .001, \eta^2 = 0.82$ , pleasure  $F(5, 15) = 4.70, p < .01, \eta^2 = 0.61$ , and tension  $F(5, 15) = 5.80, p < .01, \eta^2 = 0.66$  scales. Taken together, these results therefore suggest that line-eye configurations greatly reduce or increase the ratings of how much we enjoy looking at an emotion (liking and pleasure), as well as how much tension we perceive in the face. However, it seems that a line or set of eyes is sufficient to convey a positive or negative valence.

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Pairwise comparisons revealed that the eyes that were ranked as more positively valenced were those that displayed two convex lines, whereas the eyes giving rise to the least positive valence were the oblique oval-shaped eyes (see Figure 4). Post-hoc analyses also showed that the horizontal oval eyes and the oblique oval eyes yielded the greatest number of differences across the scales and mostly when compared with the convex eyes (see Figure 4).

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### *Forced choice task*

The participants categorized the convex and concave lines consistently with the words ‘sad’ and ‘happy’ and with the words ‘unpleasant’ and ‘pleasant’, respectively. For the emotion task, it was not possible to run inferential statistics since the participants classified each set of eyes with the same word every time. The emoticons presenting the concave line were always associated with the word “happy” while the convex line was always matched to the word “sad”. For the valence task, a GEE with a logistic regression model found a significant main effect for the line condition Wald  $\chi^2(1) = 603.34, p < .001$ . These results suggest, as expected, that the two lines that resemble a mouth can influence the categorization of an emoticon in terms of the words happy/sad and pleasant/unpleasant. There was also a significant effect of the eyes on the categorization of the emoticons in terms of the words “pleasant” and unpleasant” Wald  $\chi^2(4) = 447.23, p < .001$ . A significant interaction was found between the line and the eye type for the valence tasks Wald  $\chi^2(1) = 236.86, p < .001$ . The latter results suggest that the valence associated with a specific emoticon depends on specific line-eye arrangements.

In the emotion task, as shown by GEEs using a linear model, a significant main effect was found for RTs for the line condition Wald  $\chi^2(1) = 9.63, p < .01$ . In the valence task, the eyes had a significant effect on the RTs of the participants Wald  $\chi^2(5) = 18.91, p < .01$ . A significant interaction between the eyes and mouth-like line was also found for the valence task Wald  $\chi^2(5) = 14.75, p < .05$ . These results demonstrate that the ease with which an emoticon is matched to the words “happy or “sad” is mediated by the line condition. Dissimilarly, sorting the valence of an emoticon requires both the line and eye condition.

Furthermore, certain eye-mouth combinations were more difficult to match with a valence word. The pairing of the oblique oval eyes and the smile-like mouth produced the slowest RT, followed by the convex eyes and frown-like mouth (see Figure 5).

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## Discussion

The convex eyes presented the highest ratings in the VA scales when presented with the line that resembles a smile, followed by the concave and vertical eyes. Overall, there were greater discrepancies between the scores of each scale when the eyes were paired with the line that resembled a frown. However, the ratings consistently reflect a negative valence, a tendency towards sadness, and a dislike of experiencing the emotions conveyed by these emoticons.

What is more, those eyes that were matched to a negative valence were also perceived to produce less tension. This could perhaps be explained by either how large the area of the face that is moved or altered by each muscle (e.g., the procerus or the orbicularis oculi) is or by differences in the arousal level elicited by each of the eye-like shapes.

Regarding the forced choice task, participants' RTs were influenced by how congruent the eye-line arrangements were (see Figure 5). For example, it was hard to sort the horizontal oval eyes paired with a frown in terms of an emotion. The participants also found it more difficult to sort the concave eyes in terms of the valence words when presented together with a frown. The same was true for the horizontal oval, circle, and oblique eyes when paired with a smile. This is consistent with our predictions regarding congruent pairings of eyes and lines and association strength. This also suggests that while emoticons may be processed similarly to a face (Churches, Nicholls, Thiessen, Kohler, & Keage, 2014), specific features of each



emoticon can convey different information (perhaps just as the face does, see Du et al., 2014).

Overall, the results of Experiment 2 demonstrate that the lines that resemble a mouth (convex and concave) are consistently matched with an emotional word. The results also suggest that the lines can determine the overall valence of the emotion (as shown by both the IATs, VA scale scores, and the participants' choices in the mouse tracking task) and that it is possible that the eyes of the emoticons influence the relative valence (and perhaps also the intensity) of the emotion perceived. The eye-like shapes may be linked to the communication of particular emotions or emotional experiences. This is consistent with research on facial expressions showing that the brow and eyes actively contribute to the configuration of particular emotions (Neely, Lisker, & Drapekin, 2014). These particular emotions could be more easily associated with emotional words other than happy or sad which would explain why the pleasant-unpleasant task was more sensitive to differences than the happy-sad task. This means that it is possible that some of the eyes presented in the present study could have been communicating emotions that are not necessarily associated with either happy or sad. Further research is needed to establish whether the eyes that were chosen can communicate emotions different to joy or sadness.

### EXPERIMENT 3

In order to break down the effect of the eyes on how the participants matched emoticons (and different shapes) to a specific valence, a third experiment was conducted. The participants in our final experiment had to match different shapes that resembled eyes to four different emotion-related words (i.e., joy, anger, sadness, and fear). These emotions were chosen because they provide an even selection of emotions that are related to approach (i.e., joy),

avoidance motivation (i.e., sadness and fear), and both (i.e., anger). These four emotions also display important changes in the muscles surrounding the eyes (i.e., procerus, orbicularis oculi, levator palpebrae, and frontalis).

## Methods

*Participants:* Sixty-two participants (30 from the UK and 32 from Colombia, 32 females,  $M = 23.6$  years,  $SD = 3.8$ ,  $range = 18-32$  years) took part in this study. The experiment lasted for approximately 15 minutes.

*Apparatus and materials:* A MTS was used to present the stimuli, and record the participants' responses. The six different pairs of dots that resembled eyes that had been developed for use in Experiment 2 were once again used in this experiment (see Figure 1). The stimulus display conditions were the same as in Experiments 1 and 2.

*Procedure:* The participants were asked to classify each pair of eyes in the mouse tracking task by clicking on one of four words: anger, sad, joy, or surprise. The words were presented on the screen in a cross-like arrangement, all of the words were equidistant (measured from the last letter of each word) from the starting point. The six eyes were presented four times (4 blocks) at random for a total of 24 trials. Breaks between each block were suggested to the participants.

*Data analysis:* The participants' choices were analysed using a Pearson  $\chi^2$  Square.

## Results

A frequency analysis showed that the convex eyes were consistently associated with the word joy, while the concave eyes were more easily associated with the word sad. Participants also categorized the oblique ovals consistently and chose to match this set of eyes with anger. The

vertical ovals were more easily associated with surprise, whereas the horizontal were similarly associated to anger and sadness. The participants matched the circle eyes to the surprise and sadness (see Figure 6).

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A Pearson's Chi-squared test ( $\chi^2 = 1797.2$ ,  $df = 15$ ,  $p < .001$ ) revealed associations between each of the eye conditions and specific emotion-related words. Standardized residuals (SR) were calculated to determine whether the number of cases in a given condition were larger if the null hypothesis were true. The oblique (SR = 15.8) and horizontal ovals (SR = 10.4) were consistently matched with the word anger, with the latter presenting a weaker association when compared to the oblique ovals. The horizontal ovals were also paired with the word sadness (SR = 2.5), though the association was weaker. The convex eyes were associated with the word joy (SR = 17.8), while the concave eyes were associated with the word sad (SR = 16.9). The vertical ovals were associated with the word surprise (standardized residual = 16.4). Finally, the circle eyes showed a weak associations with the word surprise (SR = 6.6). The above results suggest that certain shapes and lines that resemble eyes can more easily convey a particular valence without the presence of other cues (i.e., lines that resemble a mouth).

## Discussion

The results of Experiment 3 demonstrate that simple shapes that resemble gestures around the eyes can communicate specific emotions. These results also show that ovals in a 45° arrangement (Figure 1C.6) that seem to form a “V” shape are more easily associated with the emotion word “anger”, as compared to the other options (see Figure 6). The concave lines

that seem to resemble eye closure are more easily matched to the word “sadness”. On the other hand, the convex eyes that could result from the activation of the orbicularis oculi are more easily associated with joy. The vertical ovals are also consistently matched with surprise. In contrast the two eye-like shapes that do not seem to be associated with specific facial expressions of emotion (i.e., horizontal and circle eyes, see Figure 6) seem to have less consistent matches.

Moreover, the results of Experiment 3 are consistent with the predictions made in Experiment 2, where it was suggested that eyes that communicated particular emotions such as the concave, convex, oblique, and vertical eyes could communicate particular emotions. These findings provide evidence that lines that resemble a mouth can influence the valence of the eyes (and perhaps other lines or shapes), *at least* if they are processed as face-like features.

## General Discussion

Consistent with previous research (see Watson et al., 2011), the results of the present study demonstrate that simple lines and geometric shapes can be used to *communicate anger, joy, sadness, and surprise*. The results of Experiment 1, in particular, revealed that the influence of concave and convex lines on participants’ judgments could be due to an embodied association with facial expressions. There is already evidence to link simple visual elements to bodily movements (Aronoff, Woike, & Hayam, 1992) and facial expressions of emotion (Aronoff, 2006; Marsh, Adams, & Kleck, 2005a, b; Tipples, 2007; Zebrowitz, 1997). *Our* results could further explain some of the findings that have been documented recently in applied contexts such as product *packaging* (e.g., Landwehr, 2016; Kumar, 2016; Salgado-Montejo et al., 2015).

The results of Experiment 2 underscore the importance of understanding how simple visual cues communicate emotion. They also demonstrate that it could be possible to “tailor” an

emotional message by arranging particular lines and shapes together. [So far, there is evidence that](#) different areas of the face are involved in the communication of distinct emotions. [For instance,](#) the amount of feedback provided by upper or lower areas of the face to discern between emotions is actually dependent on the particular emotion being displayed (Bassili, 1979). Bassili's feedback hypothesis [has been supported by work by Holstege \(2002\)](#) showing that there are specific subgroups of motor neurons innervating the upper and lower facial muscles. [That specific areas of the face are involved conveying specific emotions could be furthered supported](#) by the results of Experiment 2, showing that the specific features of an emoticon can influence the emotion [that is](#) perceived.

The prevailing evidence that there is a link between how we judge simple lines and shapes or how they influence our decisions (see Landwehr et al., 2011; Salgado-Montejo et al., 2015) with bodily response underscores the notion that embodied cognition could be involved in determining how we judge simple visual elements in everyday scenarios ([see Neidenthal, Augustinova, & Rychlowska, 2010; Zajonc, 1984](#)). This would explain why it is that the brain interprets basic lines and shapes as communicating particular emotions. [It also hints to the possibility that the face and the body are being used as a reference](#) when evaluating visual arrangements including design, art, products, and other visual information that is filled with lines and shapes. While emotion research, especially nonverbal behaviour research, has been focused on decoding complex visual features to understand emotion; our results show that the brain is capable of matching simple visual stimuli (i.e., lines and dots) to specific emotions.

The results of the present study contribute to the growing body of evidence showing that low level visual features can be linked to specific embodied representations. [Mainly,](#) that simple lines can smile (or frown) and that shapes can convey emotions. The distinct visual features of each emoticon (mouth and eyes) could be processed as particular facial expressions. In this sense, the lines that seem to be associated with emotions are, perhaps, not the result of a top-

down process that recognizes the resemblance of these lines to facial expressions of emotion. Rather, it is possible that the brain is performing a bottom-up process, [identifying](#) certain lines and shapes as [potentially containing](#) emotional information that, in later stages of visual processing, could become a facial expression of emotion.

In short, it is not that a shape or a line conveys a valence or even a specific emotion devoid of context. Evidence from electrophysiology shows that the right configuration of sensory information provides sufficient context in-and-of-itself (e.g., Ewert, 1987). A line or shape is not automatically devoid of any context. The latter would explain why stimuli that are not associated with a facial gesture can convey a valence or even an emotion. For example, LoBue (2014) reports that a line that resembles a snake can be associated with threat; but is the line really associated with a snake or is it that both the line and the snake convey the same more basic pattern of danger?

Clearly, then, more research is needed to disentangle the relationship between low and higher level visual processing in the matching of sensory information to a valence. It would be interesting to conduct electroencephalographic studies (combined with other physiological measures) focused on measuring how quickly simple visual features and facial expressions are processed and induce a motivational stance. These studies could be of great importance to assess whether emotions (and intentions) derived from in nonverbal behaviour are identified using low-level visual patterns rather than more complex arrangements.

Finally, it may be possible to take into account the evidence on facial expressions of emotion (e.g., Du [et al.](#), 2014; Ekman, 1993; Smith, Cottrell, Gosselin, & Schyns, 2005, but see Fernandez-Dols, 2013) to tailor particular emotional messages via simple [configurations of shapes and](#) lines. This could further enhance experiences in design-intensive contexts such as product and brand development, interface and web design, and advertisements.

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## END NOTES

1. Here it is important to note that these low-level visual features may not necessarily be associated with a specific emotion but rather to more basic components of the emotional experience such as valence and arousal.
2. The “V” and downward-pointing triangle could also be linked to the bared-teeth display (i.e., showing the canine teeth), displayed by many species as a sign of dominance and aggression (Bridget, Waller, & Micheletta, 2013; Maestripieri, 1996; Marsh, Kleck, & Ambady, 2005; Mignault & Chaudhuri, 2003).

## FIGURE LEGENDS

*Figure 1.* The visual stimuli presented to the participants in (a) Experiment 1, consisting of a concave, straight, and convex line with and without eyes; (b) Experiment 2, consisting of a concave and convex line, presenting variations in the shapes that resemble eyes; (c) Experiment 3, consisting of six eye-like dots: concave lines (1), convex lines (2), vertical ovals (3), horizontal ovals (4), circles (5), and oblique ovals (6).

*Figure 2.* Average D measures representing the difference between the congruent and incongruent phases in terms of an effect size in Experiment 1. Figure shows effect sizes per condition (“without eyes” and “with eyes”) and per IAT (concave-convex, concave-straight, and straight-convex). Note that higher D measures indicate that participants’ RTs were faster for the congruent stages than for the incongruent stages. They also denote those lines that were more easily associated with a particular word.

*Figure 3.* Illustrations showing: (a) The main muscles involved in the facial expressions of emotion; (b) Facial muscles with the palpebralis muscles highlighted and presenting the concave set of eyes that are associated with these muscles; (c) Illustration highlighting the orbicularis oculi muscles and the corresponding eyes at the bottom (convex eyes); (d) frontalis muscles with their corresponding set of eyes at the bottom (vertical dots); (e) Illustration with the procerus muscles highlighted and presenting the oblique eyes at the bottom.

*Figure 4.* Eyes that presented significant differences (Bonferroni corrected) in the post hoc analyses in the VA scales in Experiment 2. Asterisks indicate significant differences at the .05 level using the convex eyes as reference. In the emotion,

liking, and pleasure scales, the scores of the horizontal oval eyes and the oblique oval eyes were significantly different to the convex eyes. In the tension scale, the score of the convex eyes was significantly greater than the vertical ovals, horizontal ovals, circle, and oblique oval eyes. A significant difference was found when comparing the scores of the concave eyes with those of the horizontal ovals, circle, and oblique oval eyes. Significant differences were also found between the circle eyes and the horizontal ovals and oblique oval eyes.

*Figure 5.* The mean RTs for each condition (frown or smile-like mouth) for each of the eye-mouth pairings in the emotion and valence tasks of Experiment 2. The horizontal line presents the grand average for each condition, and the grey area the 95% confidence interval.

*Figure 6.* Frequency of choices performed by participants for each of the set of eyes presented in Experiment 3.

Table 1







*Stages of each of the IATs presented to participants during Experiment 1.*

IAT	Stages 3 and 4		Stages 6 and 7	
	Words		Words	
	Happy	Sad	Happy	Sad
Concave-convex	Concave	Convex	Convex	Concave
Concave-straight	Concave	Straight	Straight	Concave
Straight-convex	Straight	Convex	Convex	Straight
Concave-convex with eyes	Concave	Convex	Convex	Concave
Concave-straight with eyes	Concave	Straight	Straight	Concave
Straight-convex with eyes	Straight	Convex	Convex	Straight



Table 2

Mean scores of the four VA scales by the six eye conditions and the two *line* conditions (concave and convex) presented in Experiment 2

Eyes			Condition/Scale							
			Emotion	Sad		Tension	Emotion	Smile		Tension
				Liking	Pleasure			Liking	Pleasure	
		Mean	13.58	13.40	20.40	34.15	92.60	91.37	93.27	91.25
		SD	12.06	12.55	15.22	17.98	8.55	13.63	7.93	11.05
		Mean	16.15	12.35	19.70	44.18	87.88	88.15	89.32	91.27
		SD	12.48	10.21	13.30	24.02	8.64	8.64	7.93	8.84
		Mean	12.47	11.12	21.48	32.95	89.33	87.37	86.92	80.97
		SD	9.54	8.45	16.23	19.12	7.44	9.57	8.76	9.79
		Mean	14.32	9.23	11.75	21.45	78.10	67.17	74.85	69.33
		SD	10.68	8.19	9.33	16.71	12.90	20.01	14.15	19.06
		Mean	13.05	14.82	18.35	34.58	86.52	83.64	86.00	78.18
		SD	8.56	11.54	10.92	20.22	10.74	13.37	10.46	12.58
		Mean	18.22	5.78	8.43	9.03	71.33	53.23	60.78	41.60
		SD	11.51	7.63	7.30	9.28	15.02	19.05	17.82	17.57

SD = Standard deviation