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Detecting valence from unidentified images: A link between familiarity and positivity in recognition without identification

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Abstract

Research using the *Recognition Without Identification* paradigm (Cleary & Greene, 2000, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*[4], 1063–1069; Peynircioğlu, 1990, *Journal of Memory and Language*, *29*, 493–500) has found that participants can discriminate between old and new stimuli even when the stimuli are obscured to a degree that they are unidentifiable. This methodology has been adapted in the past by using heavily obscured threatening and nonthreatening images and asking participants to try to identify each image followed by a familiarity rating of the image. Past results showed that threatening images that were not able to be identified were rated as more familiar than nonthreatening images that were not able to be identified (Cleary et al., 2013, *Memory & Cognition*, *41*, 989–999). The current study used a similar methodology to explore the possibility that a sense of familiarity can serve to guide our attention toward potential threats in the environment. However, contrary to earlier results, we found that positive images were rated as more familiar than negative images. This pattern was found with both identified and unidentified images and was replicated across five experiments. The current findings are consistent with the view that feelings of positivity and familiarity are closely linked (e.g., de Vries et al., 2010, *Psychological Science*, *21*[3], 321–328; Garcia-Marques et al., 2004, *Personality and Social Psychology Bulletin*, *30*, 585–593; Monin, 2003, *Journal of Personality and Social Psychology*, *85*[6], 1035–1048).

Keywords Recognition without identification · Familiarity · Valence

Virtually all human experiences are seen through a filter of emotion, influencing how we perceive and remember events. Emotional stimuli capture our attention (e.g., Nummenmaa et al., 2006) and are remembered better compared with less emotionally laden events (see Kensinger, 2009; Yonelinas & Ritchey, 2015, for reviews). Past research has also shown that emotional aspects of an event can be detected and can guide behavior even if identification of the stimulus itself fails. For example, emotion-based learning has been shown to remain intact in individuals with anterograde amnesia. Even though a previous experience with a stimulus cannot be explicitly remembered, these individuals will show memory for the emotional aspects of that stimulus, such as avoiding things that were harmful in the past (Turnbull & Evans, 2006). This is illustrated in a classic example from Claparède (1911), who hid a pin in his palm before shaking the hand of an amnesic patient. The next day, the patient had no explicit memory of this or him, but she refused to shake his hand. This is an interesting example of how emotion-based learning can guide our behaviors outside of conscious recollection, and we suspect that similar phenomena are probably present in more everyday experiences. For instance, imagine encountering a familiar name. Although you may be unable to identify the person or remember anything specific about him or her, you may have a sense of whether your past experience with that person was positive or negative.

The idea that we can access and use information about stimuli even when they cannot be identified has been supported by research on a phenomenon termed *recognition without identification* (RWI). In the first known demonstration of a list-learning RWI paradigm (Peynircioğlu, 1990), participants were presented with a word list to study and were later presented with word fragments so that the identity

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and meaning of the words were obscured (e.g., R _ _ N D _ _ P for the study word RAINDROP). The key finding is that, even when participants are unable to identify the word, they can reliably discriminate between old and new test words when asked to make a recognition decision for the fragment. This shows that recognition memory is not entirely conceptually driven, as the concept of the word is not recognized but rather just a particular arrangement of letters feels familiar.

This method has also been used with other types of stimuli, such that participants are presented with a study list during the encoding phase, and subsequent identification of the test items is hindered or made difficult in some manner. This type of RWI is extremely robust, occurring with visual word fragments (Cleary & Greene, 2000, 2001; Peynircioğlu, 1990), rapidly flashed masked words (Arndt et al., 2008; Cleary & Greene, 2004, 2005; Morris et al., 2008), phoneme fragments of spoken words (Cleary et al., 2007), picture fragments (Cleary et al., 2004), rapidly flashed masked pictures (Langley et al., 2008), note fragments of songs (Kostic & Cleary, 2009), and even unidentifiable odors (Cleary et al., 2010).

The studies above use a list-learning RWI paradigm, but far fewer studies have employed more real-world discrimination tasks that do not involve a study phase. Instead, recognition of obscured test items relies on prior knowledge. For example, Bolte and Goschke (2008) found that participants could discriminate between coherent and scrambled versions of unidentified fragmented line drawings, and this discrimination seems to be based on general knowledge rather than presentation on a study list. In a similar non-list-learning RWI paradigm investigating the influence of preexperimental familiarity, Cleary et al. (2013) applied a visual noise filter to images of famous actors (Experiment 1) and famous locations (Experiment 2). The filter obscured the images, making them difficult to identify. Similar to Bolte and Goschke, there was no study phase in this experiment; participants simply attempted to identify these images and then gave a familiarity rating. The scenario of greatest interest was when participants could not identify the image. The results showed that even when the filter prevented identification, participants could still discriminate between famous and novel faces/locations.

The finding of an RWI effect relying on preexperimental familiarity as opposed to a defined study phase led Cleary et al. (2013, Experiment 3) to investigate the possible evolutionary benefits of this phenomenon, focusing on threat detection and the ability to make snap judgments in the face of minimal information. The stimuli were images that varied in threat level (threatening or nonthreatening) and animacy (animate or inanimate) that were filtered to obscure identification. There was no study phase in their experiment; participants simply saw each obscured image, tried to identify it, and then rated how familiar it seemed on a scale of 1 to 10. The main finding was that, for images that were not identified, the threatening images were rated as more familiar than the nonthreatening images. Furthermore, this effect was only seen for images depicting living things.

The finding that threatening stimuli were rated as more familiar (Cleary et al., 2013, Experiment 3) is the focus of the present study. The results are intriguing, in part because they seem to represent a departure from prior literature that has shown a strong link between positivity and a sense of familiarity. It has long been theorized that a sense of familiarity helps guide our behaviors toward favorable outcomes, which can range from simple hedonic preferences to survival-related benefits. Indeed, the relationship between familiarity and positivity is deeply entrenched in psychology, beginning with Titchener (1910), who described familiarity as a "glow of warmth . . . a comfortable feeling" (p. 408). Since this early observation, there has been much empirical work establishing the relationship between familiarity and affective preference (e.g., Zajonc, 1968; for a review see Garcia-Marques et al., 2013), with the role of processing fluency being identified as a common link. One prominent account of this relationship, the *hedonic marking hypothesis* (Winkielman et al., 2003), states that a stimulus that is processed relatively fluently, whether due to previous exposure, context, or stimulus qualities, is associated with positive emotional experience. In this view, judgements related to familiarity are likewise affected by fluency because familiarity is assumed to be an inherently positive quality. A possible reason that familiarity and positivity are closely linked is that familiarity signals safety relative to the uncertain outcomes associated with encountering novel stimuli. Indeed, stress induction has been shown to increase preferences for the familiar, even when the familiar option is more difficult or time-consuming (Litt et al., 2011), while happy mood induction decreases preferences for the familiar (de Vries et al., 2010). Additionally, positive mood has been shown to increase feelings of familiarity (Claypool et al., 2008), as well as attractive faces (Corneille et al., 2005), suggesting that positivity is misattributed to feelings of familiarity. Thus, the strong link between familiarity and positivity is bidirectional.

It is important to note that the ample evidence for the association between positivity and familiarity in the literature utilizes stimuli that are consciously identifiable. However, much less is known about valence recognition for stimuli that are not consciously identifiable due to a visual mask, and the underlying mechanisms are not well understood. However, given that familiarity is typically associated with safety and positive affect (Reber et al., 1998; Westerman et al., 2015; Whittlesea, 1993; Winkielman et al., 2003), and that this link is bidirectional (Claypool et al., 2008; Corneille et al., 2005) one might expect the positive images would be rated as more familiar than the negative images—the opposite of what was found by Cleary et al. (2013). In addition, the images that were used in their study were obtained from the International Affective Picture System (IAPS; Lang et al., 2005). This image set includes normed ratings of image familiarity in addition to valence and arousal, and the norms indicate that, generally speaking, positive images in the database are rated as more familiar than negative images (Libkuman et al., 2007). Although the images were obscured, research on *perception without awareness* suggests that participants can often identify the affective information of stimuli that is below the threshold for conscious identification (see Merikle et al., 2001, for review). Given this, it would seem that obscured nonthreatening images may still be perceived to be more positive than threatening images. Because familiarity is associated with *positive* affect and given the research suggesting that participants can detect affective information of below threshold stimuli, why did participants rate threatening (i.e., negative) images as more familiar?

In their article, Cleary et al. (2013) theorized that the feeling of familiarity in response to an obscured threatening image could potentially be the result of a bottom-up process serving to direct attention toward potentially threatening situations, and participants attributed the attentional capture as a sense of familiarity. This explanation is consistent with the notion that familiar stimuli seem to "pop out" from their backgrounds (Jacoby, 1991; Q. Wang et al., 1994). However, the effect of threat on attention capture is unclear, with some studies showing threat captures attention (e.g., New & German, 2015) and others showing that it does not (e.g., Calvillo & Hawkins, 2016). Interestingly, Calvillo and Hawkins (2016) found that attention capture occurred as a result of animacy, but not threat. Additionally, Öhman et al. (2001) found that attention is only captured by threatening stimuli for people with fears of those items, but they did not find a general effect of threat on attention capture, adding to the inconsistent findings of threat on attention capture.

If the findings of Cleary et al. (2013, Experiment 3) are indeed due to attention capture, it is possible that this attention capture is similar to the experience of processing fluency, which, as reviewed above, has been shown to engender a feeling of familiarity for a stimulus (Winkielman et al., 2003). A related possibility is that the early processing of visual information could serve to guide attention to threatening situations by means of processing fluency. Although this seems to be contradicted by the literature showing that positive affect arises from fluent processing, it is possible that the link between processing fluency, familiarity, and liking are a result of a later stage of processing that relies on conscious identification of the stimuli. Processing of valence prior to conscious identification, on the other hand, could be employing a different strategy with the aim of guiding attention to important aspects in the environment.

A critical factor in research regarding emotion is that emotion varies on two dimensions, valence (whether something is positive or negative) and arousal (the intensity of the emotion). Arousal has shown to be an important factor in memory for emotional stimuli, and there is evidence that it may be even more predictive of memory performance than valence for both immediate and delayed recall (Bradley et al., 1992). This suggests that the dimensions of valence and arousal have differing effects on memory, and this difference is important to account for in experiments aiming to investigate the effects of either dimension. Prior studies have shown that arousal, often measured by amygdala activation or skin conductance responses, can be experienced in response to stimuli that are not consciously identified (Diano et al., 2017; Esteves et al., 1994; Gläscher & Adolphs, 2003; Ohman, 2005), and is thought to be the result of an evolutionary benefit for detecting threat. Additionally, there is some evidence suggesting that physiological arousal may evoke feelings of familiarity. For example, Goldinger and Hansen (2005) found that participants were more likely to classify items as "old" during a recognition test when exposed to an unexplained source of arousal, which was a low-amplitude buzz. Similarly, Morris et al. (2008) found a positive relationship between recognition ratings for unidentified masked stimuli and skin conductance responses, suggesting that autonomic arousal induced by the increased cognitive processing of information that is difficult to retrieve may invoke feelings of familiarity. Because the images used by Cleary et al. (2013) were not equated on the arousal dimension, the positive relationship between threat and familiarity ratings may in fact be due to arousal and not valence.

Yet another possible reason that the threatening images were rated as more familiar in the Cleary et al. (2013) experiment, is that the threatening information that comes through the noise filter may generate pause in participants (e.g., Goldinger & Hansen, 2005; Whittlesea, 1997), which may, in turn, initiate top-down motivational processes. Humans want to experience pleasant things and avoid unpleasant things. This is a baseline motivation, and these motivational states can alter conscious perceptions, especially in the face of ambiguity (Balcetis & Dunning, 2006). Viewing the Cleary et al. (2013) study in this light, perhaps the absence of motivation for threat detection resulted in a signal that was ambiguous given the inability to consciously identify the image. Because participants are assumed to have a baseline motivation to experience positive things, this could have turned into a distorted signal that there was *something* notable about the image, which ended up being ascribed to a sense of familiarity, as that was the question at hand.

The present study

The goal of the present research is to reconcile the conflicting ideas reviewed above regarding how emotional aspects of a stimulus may guide our judgements even for unidentified stimuli. In Experiments 1–4, we used positive and negative images (vs. threatening and nonthreatening images as used by Cleary et al., 2013) in this study. This choice was partly practical: The image database from which we (and Cleary et al., 2013) obtained the stimuli does not include norming data related to threat, per se (Lang et al., 2005; Libkuman et al., 2007). More importantly, we thought that using positive and negative stimuli would allow greater generality in our results, as "threat" would seem to be a subset of "negative." Given that our primary question concerns the link between positivity and familiarity, we thought that using positive and negative images would best address these more general goals. Moreover, if unidentifiable negative stimuli are perceived as more familiar, then this would have implications for theories that propose that positive affect and familiarity are strongly linked.

We were also interested in whether the arousal dimension of emotion is a required factor in detecting emotion in unidentifiable images. It is not yet known whether valence alone is sufficient in detecting emotion in images that are below the threshold of identification and whether that information can be used to make familiarity judgments. We therefore used an image set equated on arousal in Experiment 4 to examine the possibility that high arousal leads to increased feelings of familiarity for unidentifiable images. In Experiment 5 we used the same threatening and nonthreatening images used by Cleary et al. (2013).

Power analysis

The number of participants in this study was determined by a power analysis conducted using G*Power (Faul et al., 2007). We assumed a medium effect size ($d = .5$), as found in Cleary et al. (2013, Experiment 3). This analysis revealed that an $N = 54$ would result in a power level of .95 using a .05 significance criterion. Any deviations from this were due to counterbalancing and scheduling.

Experiment 1

An implicit assumption of past research outlined above, is that participants have some sense whether an image is positive or negative even if they cannot identify the content of the image. In other words, we are assuming that there is enough information coming through the filter to identify some of the affective qualities of the image but not enough for conscious identification of the content. If this assumption is correct, then participants should be able to accurately judge whether an image is positive or negative even when it cannot be identified. The goal of Experiment 1 is therefore to test whether participants can accurately judge whether the image behind the filter is positive or negative.

Method

Participants Participants for this experiment included 53 Binghamton University undergraduate students who were compensated with partial credit toward a course requirement.

Materials The stimuli were 83 images from the International Affective Picture System (IAPS; Lang et al., 2005) and five images from the Open Affective Standardized Image Set (OASIS; Kurdi et al., 2017), both of which include normative valence ratings. The latter five images were used in order to have an even number of images in each category. Images were either positive ($M = 7.41$, $SD = 0.38$) or negative ($M = 2.51$, $SD = 0.82$) and depicted either animate or inanimate things, with 22 images in each of the four categories (all five OASIS images used were in the negative-inanimate category). Valence ratings were matched between respective animate and inanimate categories. As mentioned previously, the dimension of arousal was not controlled for in this experiment. The images were 350 × 350 pixels and were filtered in Photoshop using a monochromatic Gaussian noise filter of 150% to hinder identification. This filter was used by Cleary et al. (2013) and was successful at hindering identification. A list of the exact images and their descriptions can be found on the Open Science Framework (https://osf.io/kwc9m/?view_only=00ff285ab6cd46e7a16f17808c80fc19).

Procedure All 88 filtered images were presented in a different random order for each participant. With the image present on a screen, participants were asked to try to identify the image content by typing a response. Regardless of whether or not they produced a correct identification, participants were then asked to rate whether the image seemed positive or negative by pressing P or N on a keyboard. This was a forced-choice binary response. Each trial was self-paced, but participants were encouraged to move on after 5–10 seconds if they were unable to identify it. The exact directions were as follows:

> "In this experiment, you will be rating a series of images. The images are filtered so that they are fuzzy and difficult to see. For each image, you will do 2 things:

(1) Identify the image.

Type your response using the keyboard. If you don't know what the image is, please use the "Don't know" button located on the bottom of the screen.

(2) Give a rating of whether you think the underlying image is positive (good) or negative (bad). Even if you cannot figure out what the image is, just give your best guess. This could be a "gut" feeling. Use the P and N keys on your keyboard."

Table 1 Percentage of images identified by experiment and image category

Exp.	Negative inanimate	Negative animate	Positive inanimate	Positive animate
1	10%	11%	15%	23%
2	8%	9%	13%	21%
3A	16%	12%	20%	33%
3B	18%	23%	29%	43%
4	4%	4%	19%	23%
5	31%	41%	56%	62%

Results

The noise filter was successful at hindering identification, with an overall identification rate of 15% (see Table 1 for a breakdown by image category). The trials of interest were those in which the image could not be unidentified. As such, trials with successful identification were excluded in the analysis.

The dependent variable was the proportion of "positive" responses. A 2 (valence: positive vs. negative) × 2 (animacy: animate vs. inanimate) repeated-measures analysis of variance (ANOVA) revealed a main effect of valence, where positive unidentified images were rated more positively ($M = .586$, $SD = .15$) than negative images ($M = .533$, $SD = .167$), $F(1, 52) = 15.33$, $p < .001$, $MSE = .01$, $\eta_p^2 = .228$. There was no significant difference in positivity ratings between animate ($M = .547$, $SD = .16$) and inanimate ($M = .573$, $SD = .161$) images, $F(1, 52) = 2.899$, $p = .095$, $MSE = .012$, $\eta_p^2 = .053$. There was no interaction between valence and animacy, $F(1, 52) = 1.416$, $p = .239$, $MSE = .013$, $\eta_p^2 = .027$ (see Fig. 1).

We also used signal detection analyses to disambiguate response bias from accuracy. The sensitivity measure d' was computed for each participant, and the mean was significantly above zero (chance), ($M = 0.41$, $SD = 0.24$), $t(52) = 12.45$, $p < .001$, $SE = .033$, $d = 1.71$, showing evidence of

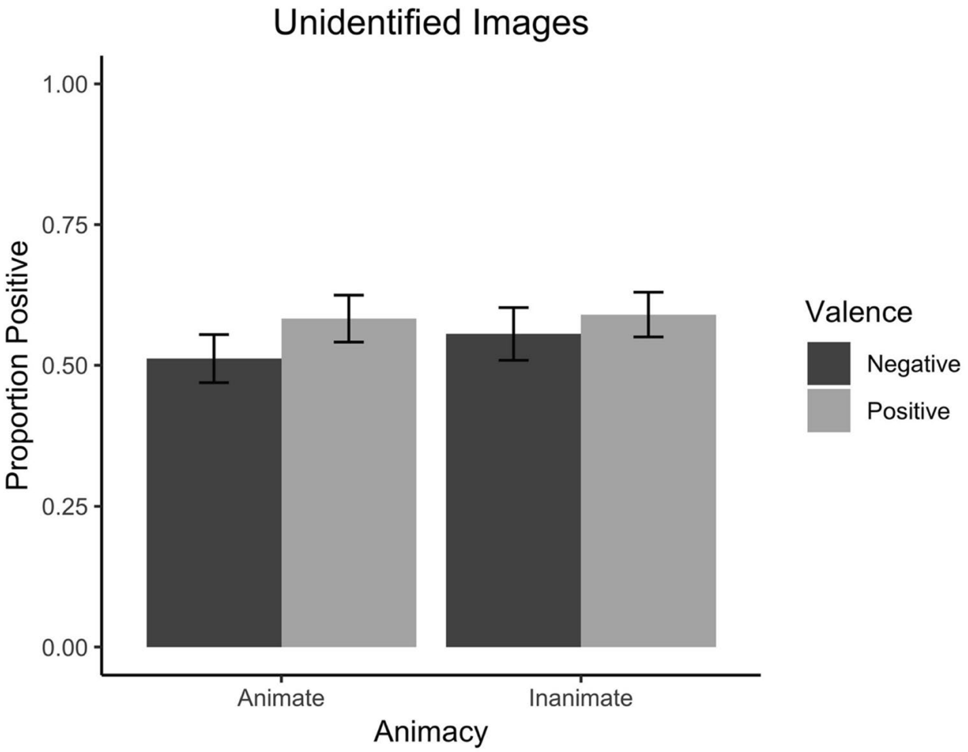

Fig. 1 Results of Experiment 1. Participants rated the unidentified images as either positive or negative. Error bars represent 95% confidence intervals

accurate valence discrimination, consistent with the findings of the previous analysis.

Consistent with past research on perception without awareness, the results of Experiment 1 suggest that participants can discriminate between positive and negative images even when they cannot identify the content of the photo.

Experiment 2

Our second goal was to determine whether unidentified negative images would be rated as more familiar than unidentified positive images. This is similar to the experiment by Cleary et al. (2013), with the main difference being that we used positive and negative images rather than threatening and nonthreatening images per se.

Method

Participants Participants were 63 Binghamton University undergraduate students who were compensated with partial credit toward a course requirement.

Materials The materials were identical to Experiment 1.

Procedure The procedure was identical to that of Experiment 1, except that instead of rating the images on whether they seemed positive or negative, participants rated how familiar the image seemed on a scale from 1 to 8. The exact directions for the familiarity rating were as follows:

"Rate the image on how familiar it seems to you. This could be a vague feeling that you may have seen the underlying image at some point before this experiment. Submit your response using the number keys on top of the keyboard."

Results

The noise filter was again successful at hindering identification, with an overall identification rate of 13% (see Table 1 for a breakdown by image category). Trials of interest were those in which the image could not be identified. As such, trials with successful identification were not included in the main analyses. The dependent variable was the familiarity ratings given to the images. A 2 (valence: positive vs. negative) × 2 (animacy: animate vs. inanimate) repeated-measures ANOVA revealed a main effect of valence, where positive unidentified images were rated as more familiar ($M = 2.76$, $SD = 1.03$) than negative images ($M = 2.34$, $SD = 1.13$), $F(1, 62) = 95.24$, $p < .001$, $MSE = .12$, $\eta_p^2 = .606$. There was also a main effect of animacy, where animate images were rated as more familiar ($M = 2.69$, $SD = 1.15$) than inanimate images ($M = 2.41$, $SD = 1.02$), $F(1, 62) = 24.745$, $p < .001$, $MSE = .19$, $\eta_p^2 = .285$. There was not a significant interaction between valence and animacy, $F(1, 62) < 1$, $p = .496$, $MSE = .11$, $\eta_p^2 = .008$, (see Fig. 2).

Although not the focus of this experiment, we note that the same pattern was found for the images that were identified. Positive images ($M = 5.09$, $SD = 1.51$) were rated as more familiar than negative images ($M = 4.72$, $SD = 1.73$), $t(62) = 2.26$, $p = .03$, $d = 0.29$, and animate images ($M = 5.4$, $SD = 1.57$) were rated as more familiar than inanimate images ($M = 4.25$, $SD = 1.75$), $t(60) = 7.2$, $p < .001$, $d = 0.92$.

In summary, contrary to past research, we found that among unidentified images, positive images were rated as more familiar than negative images. Although not a focus of this inquiry, we also found that unidentified images depicting animate subjects were rated as more familiar than images depicting inanimate subjects, replicating the results of Cleary et al. (2013).

Experiments 3A and 3B

In Experiment 2, unidentified positive images were rated as more familiar than unidentified negative images. These results are contrary to the results of Cleary et al. (2013, Experiment 3). Although we used the same image filter and similar stimuli as the previous study, we note that there was a discrepancy between our identification rates of 13% and that of Cleary et al. of 32%. It is possible that this discrepancy in identification rates can account for the disparate results, therefore in Experiments 3A and 3B we reduced the intensity of the filters to augment identification rates. Otherwise, the experiments were the same as Experiment 2.

Method

Participants Participants included a total of 58 (30 in 3A and 28 in 3B) Binghamton University undergraduate students who were compensated with partial credit toward a course requirement.

Materials The materials were the same as in Experiment 1, with the exception of the filter intensity. A Gaussian monochromatic noise filter of 125% was used in Experiment 3A, and 110% in Experiment 3B.

Procedure The procedure was identical to that used in Experiment 2.

Results

The overall identification rates for Experiments 3A and 3B were 20.3% and 27.9%, respectively (see Table 1 for a

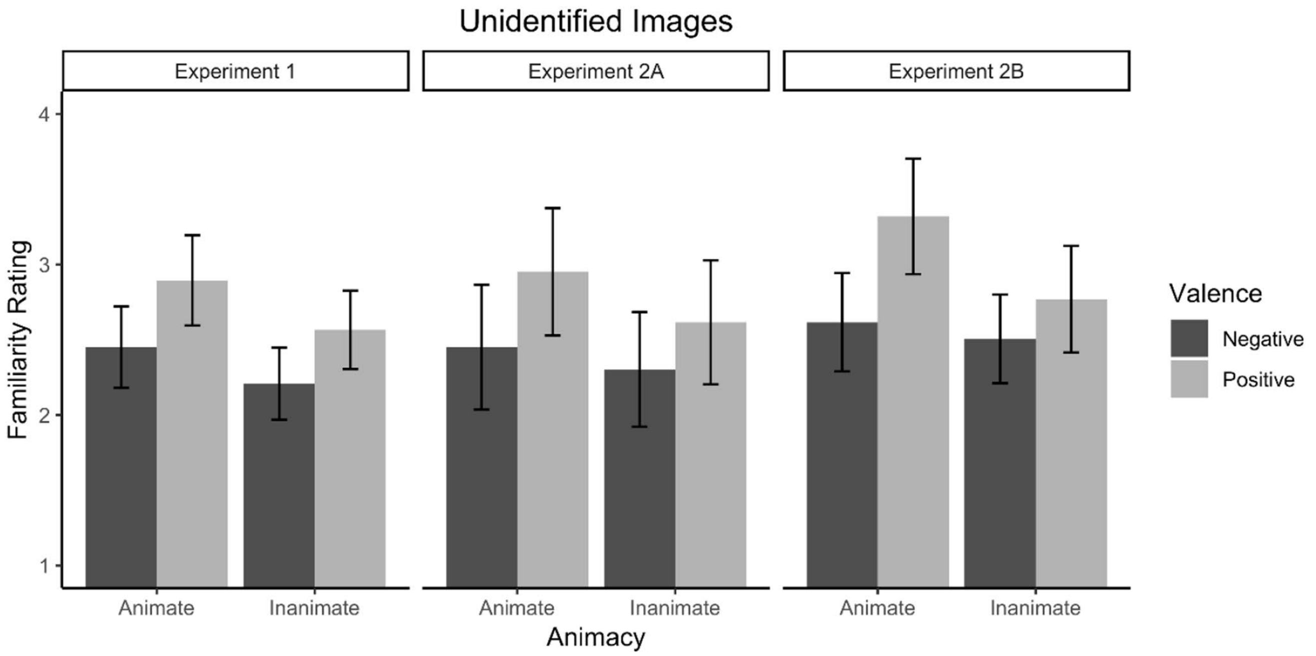

Fig. 2 Results of Experiments 2, 3A, and 3B, with a Gaussian monochromatic noise filter of 150% (Experiment 2), 125% (Experiment 3A), and 110% (Experiment 3B). Participants rated the unidentified images on a scale from 1 (*not familiar*) to 8 (*very familiar*) Error bars represent 95% confidence intervals

breakdown by image category). For both filters, there was a main effect of valence, where positive images (3A: $M = 2.8$, $SD = 1.14$; 3B: $M = 3.01$, $SD = .95$) were rated as more familiar than negative images (3A: $M = 2.42$, $SD = 1.12$, 3B: $M = 2.56$, $SD = .8$), 3A: $F(1, 29) = 23.54$, $p < .001$, $MSE = .21$, $\eta_p^2 = .45$; 3B: $F(1, 27) = 50.8$, $p < .001$, $MSE = .13$, $\eta_p^2 = .65$. There was also a main effect of animacy, where animate images (3A: $M = 2.7$, $SD = 1.11$; 3B: $M = 2.92$, $SD = .9$) were rated as more familiar than inanimate images (3A: $M = 2.48$, $SD = 1.12$, 3B: $M = 2.62$, $SD = .85$), 3A: $F(1, 29) = 15.96$, $p < .001$, $MSE = .13$, $\eta_p^2 = .36$; 3B: $F(1, 27) = 21.45$, $p < .001$, $MSE= .14$, $\eta\ \eta_p^2 = .44$. There was no significant interaction in Experiment 3A, $F(1, 29) = 2.32$, $p = .14$, $MSE = .14$, $\eta_p^2 = .02$, but the interaction was significant in Experiment 3B, $F(1, 27) = 8.56$, $p = .007$, $MSE = .16$, $\eta_p^2 = .24$, such that higher familiarity ratings were given for animate items only in the positive category, $t(27) = 4.69$, $p < .001$, $d = 0.89$. There was no effect of animacy in the negative category, $t(27) = 1.26$ $p = .22$, $d = 0.24$. In sum, despite the higher identification rates in Experiments 3A and 3B, the patterns of results were similar to those of Experiment 2 (see Fig. 2).

The familiarity ratings of identified images follow a similar pattern. Positive images (3A: $M = 5.54$, $SD = 1.36$; 3B: $M = 5.65$, $SD = 1.32$) were rated as more familiar than negative images (3A: $SD = 5.17$, $SD = 1.58$; 3B: $M = 5.33$, $SD = 1.25$) in both Experiment 3A, albeit just shy of significance, $t(29) = 1.94$, $p = .06$, $d = 0.35$, and 3B, $t(27) = 2.08$, $p = .048$, $d = 0.39$. Animate images (3A: $M = 5.67$, $SD = 1.34$; 3B: $M = 5.63$, $SD = 1.23$) were rated as more familiar than inanimate images (3A: $SD = 5$, $SD = 1.6$; 3B: $M = 5.46$, $SD = 1.4$) in Experiment 3A, $t(29) = 3.9$, $p < .001$, $d = 0.71$, but not in Experiment 3B, $t(27) = 1.12$, $p = .27$, $d = 0.21$.

The results of Experiments 2, 3A, and 3B are counter to the idea that unidentified threatening/negative images will appear to be more familiar than unidentified nonthreatening/positive images. Instead, we found that among unidentified images, positive images were rated as more familiar. We consistently find this effect when decreasing the intensity of the image filters to more closely match identification rates of previous findings. Making the images more identifiable by lowering the filter did not change the pattern of results, suggesting accurate valence identification among unidentified images as a robust finding.

Experiment 4

The specific qualities of the images that were used in Experiments 1–3 may explain why our results differed from prior research. Importantly, there are two dimensions of emotion, valence (whether something is positive or negative) and arousal (the intensity of the emotion), and each dimension appears to affect memory with different underlying mechanisms (Kensinger, 2004). The image sets used in Experiments 1–3, as well as those used by Cleary et al. (2013, Experiment 3), were not equated on arousal, and therefore, the results could have been an effect of arousal and not valence.

As previously mentioned, there is evidence that arousal does indeed influence participants' ratings for unidentifiable stimuli (e.g., Goldinger & Hansen, 2005; Morris et al., 2008). However, it is not yet known whether valence can be detected through a noise mask for unidentified images independent of arousal, and whether this information alone can be used to make decisions about familiarity. It is thus important for the present study to analyze the effect of valence while holding arousal constant, as it may shed light on the underlying mechanisms of valence recognition without image identification. The goal of Experiment 4 was therefore to explore this possibility by using a new image set in which arousal was equated across all conditions.

Method

Participants Participants for this experiment included 66 Binghamton University undergraduate students who were compensated with partial credit toward a course requirement. Due to restrictions related to COVID-19, this experiment was conducted online using Pavlovia.

Materials The stimuli were 80 images from the International Affective Picture System (IAPS; Lang et al., 2005, with 20 images in each category. As before, valence ratings were matched between animate and inanimate categories for both positive ($M = 7.31$, $SD = 0.37$) and negative ($M = 2.76$, $SD = 0.32$) categories. The same filter as in Experiment 1 was used. Importantly, the image sets were equated on arousal, such that there were no significant differences in arousal between any of the four categories (M = 4.81–4.9, SD = 0.18–0.45), $F(3, 76) < 1$, $p = .74$, $MSE = .08$, $\eta_p^2 = .02$. A list of the exact images and their descriptions can be found on the Open Science Framework (https://osf.io/kwc9m/?view_only=00ff285ab6cd46e7a16f17808c80fc19).

Procedure The procedure was identical to that of Experiments 2–3.

Results

The overall identification rates for Experiment 4 were 16.5% (see Table 1 for a breakdown by image category). There was again a main effect of valence, $F(1, 65) = 34.68$, $p < .001$, $MSE = .12$, $\eta_p^2 = .35$, where positive images ($M = 2.05$, $SD = .95$) were rated as more familiar than negative images ($M = 1.8$, $SD = .76$). There was a main effect of animacy, $F(1, 65) = 27.2$, $p < .001$, $MSE = .12$, $\eta_p^2 = .30$, where animate images ($M = 2.02$, $SD = .92$) were rated as more familiar than inanimate images ($M = 1.82$, $SD = .8$). There was no interaction, $F(1, 65) < 1$, $p = .79$, $MSE = .04$, $\eta_p^2 = .001$ (see Fig. 3).

The familiarity ratings of identified images again followed the same pattern. Positive images ($M = 3.32$, $SD = 1.28$) were rated as more familiar than negative images ($M = 3.04$, $SD = 1.35$), $t(55) = 3.1$, $p = .003$, $d = 0.42$. However, there was no difference between animate ($M = 3.61$, $SD = 1.24$) and inanimate items ($M = 3.46$, $SD = 1.18$), $t(38) = .92$, $p = .36$, $d = 0.15$.

To summarize, arousal was equated in Experiment 4. However, the results showed the same pattern as was found in Experiments 2 and 3, showing, once again, that positive valence is perceived as a sense of familiarity even when the image cannot be identified, and these effects cannot be explained by differences in arousal.

Experiment 5

The results of Experiments 2–4 show that positive images are more likely to be classified as familiar, independent of arousal, which seems at odds with the results of Cleary et al. (2013). One possible reason for the discrepancy is that somewhat different images were used in each study. There are more than 1,000 images in the IAPS database, so it is possible that the types of images we chose are responsible for the differing results. A potentially more substantial issue is that Cleary et al. (2013) categorized their images as nonthreatening versus threatening, while the present experiments categorized them as positive versus negative. This could potentially be a contributing factor for the conflicting results, as nonthreatening could be synonymous with neutral as opposed to positive. The present experiments did not include a neutral image category, and it is possible that neutrally valenced images could lead to processing that is different than that of images on the extreme ends of the valence scale. As mentioned in the introduction, the normative ratings provided with the IAPS database do not include a "threat" category. However, in an attempt to better understand the degree to which our positive and negative images line up with threat versus nonthreat, we conducted an additional study asking a new sample of participants from the same pool as participated in Experiments 1–4 to provide ratings for the images used in the present experiments as either positive/negative ($N = 24$) or nonthreatening/threatening ($N = 24$). In an item-wise comparison, we found a very strong positive correlation between valence ratings and threat ratings, $r(79) = .93$, $p < .001$, suggesting that the constructs are highly overlapping, with 86% shared variance. In sum, our results suggest that positive/negative image categories should largely correspond with nonthreatening/threatening image categories.

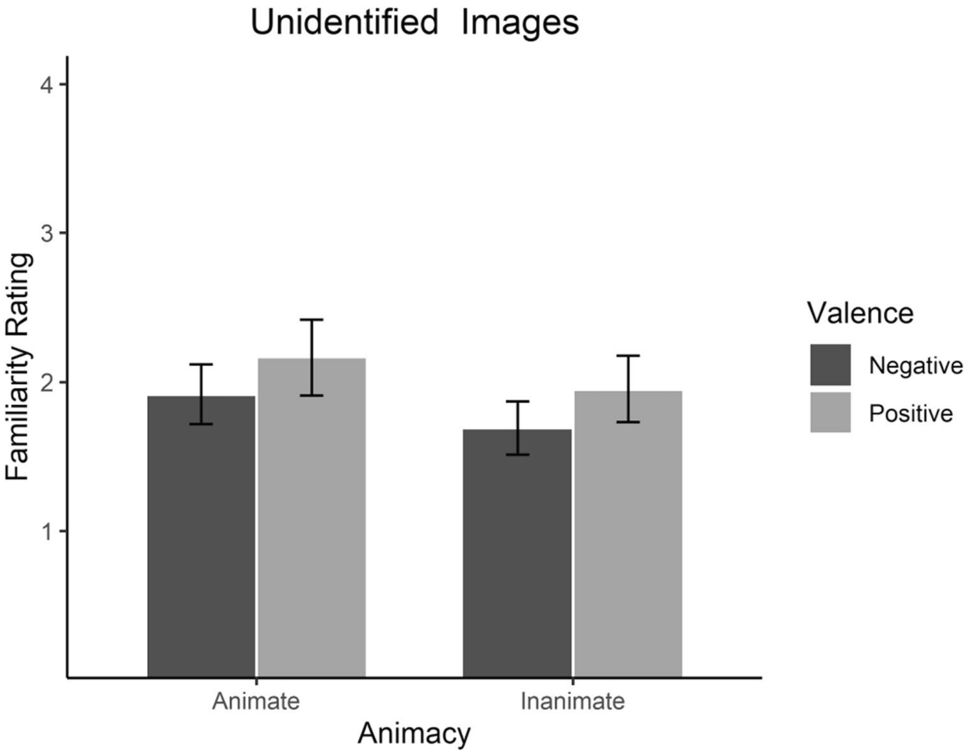

Fig. 3 Results of Experiment 4. Images were equated on arousal. Error bars represent 95% confidence intervals

Nevertheless**,** in Experiment 5, we used the exact images used by Cleary et al. (Experiment 3) to investigate whether our image sets were fundamentally different and would produce different results. The most notable difference between the two stimuli sets was in the animate category. Both of our animate sets included pictures involving humans as well as animals, while the set used in Cleary et al. was composed exclusively of animals. It is therefore reasonable to consider that our results may be tapping into a somewhat different phenomenon. Other than the stimuli, Experiment 5 was identical to Experiment 2.

Method

Participants Participants for this experiment included 51 Binghamton University undergraduate students who were compensated with partial credit toward a course requirement.

Materials The stimuli used were the exact filtered images used by Cleary et al. (2013, Experiment 3) with permission. While our method of filtering our own image sets used in Experiments 1–4 followed the same process as reported in Cleary et al., we used the authors' prefiltered images in an attempt to replicate their experiment as closely as possible. This image set included 80 images, with 20 in each of the following categories: living-threat, living-nonthreat, nonliving-threat, and nonliving-nonthreat.

Procedure The procedure was identical to Experiment 2.

Results

The image filter was less successful at hindering identification than earlier experiments, yielding an overall identification rate of 48% (see Table 1 for a breakdown by image category).

Among unidentified images, a 2 (animacy: inanimate vs. animate) × 2 (threat: threatening vs. nonthreatening) ANOVA revealed a main effect of animacy, where animate images (M = 2.11, SD = .66) were rated as more familiar than inanimate images (M = 1.97, SD = .69), $F(1, 50)$ = 10.6, p = .02, MSE = 0.17, η_p^2 = .18. There was also a main effect of threat: nonthreatening images (M = 2.19, SD = .73) were rated as more familiar than threatening images (M = 1.93, SD = .66), $F(1, 50)$ = 19.97, $p < .001$, MSE = 0.19, η_p^2 = .29. There was also an interaction, $F(1, 50)$ = 9.75, p = .03, MSE = 0.26, η_p^2 = .16, between animacy and threat. Follow-up t tests revealed that familiarity ratings were higher for nonthreatening images in the animate category, $t(50)$ = 5, $p < .001$, SE = .09, d = 0.70, but not in the inanimate category, $t(50) < 1$, p = .55, SE = .10, d = 0.09 (see Fig. 4).

Among identified images, there was a main effect of threat, where nonthreatening images were rated as more familiar (M = 4.90, SD = 1.03) than threatening images (M = 4.09, SD = 1.13), $F(1, 50)$ = 101.01, $p < .001$, MSE =

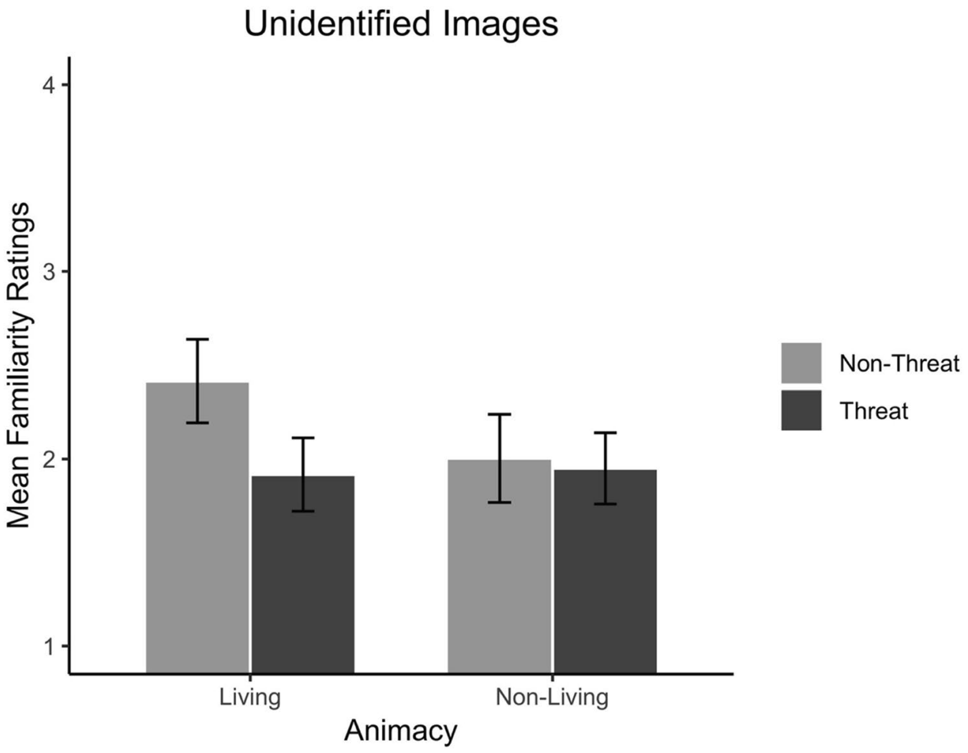

Fig. 4 Results of Experiment 5, using the same images as Cleary et al. (2013). Error bars represent 95% confidence intervals

0.33, $\eta_p^2 = .67$, no main effect of animacy, $F(1, 50) = 1.11$, $p = .30$, $MSE = 0.27$, $\eta_p^2 = .02$, and no interaction, $F(1, 50) < 1$, $p = .86$, $MSE = 0.21$, $\eta_p^2 = .01$.

The basic effect we found in Experiments 2–4 replicated here, with the nonthreatening images rated as more familiar. There was, however, an interaction in which this effect was only seen for images of animate things, replicating the interaction seen in Experiment 3B. This may be due to the increased identification rates seen in Experiment 4, suggesting further that the effect of animacy on positive images relies on less intense image filters.

In sum, our results did not differ materially when we used the images used by Cleary et al. (2013). Although there were differences in the nature of the images and the identification rates, the finding that the more positive/nonthreatening images are rated as more familiar compared with the negative/threatening images appears robust.

General discussion

Our study yielded two key findings. First, we found that participants could discriminate between positive and negative images, even when they could not be identified (Experiment 1), consistent with the emotion-perception without awareness literature. Past studies on perception without awareness tended to use either emotional faces or valenced words, but studies using complex scenes such as the IAPS are scant (Kimura et al., 2004). The present research suggests that this effect does indeed extend to complex scenes. We also note that in typical perception without awareness experiments, the ability to consciously identify the stimulus is manipulated either by stimulus duration (e.g., Murphy & Zajonc, 1993; Pessoa et al., 2005) or stimulus location relative to an attended stimulus (e.g., Mack & Rock, 1998; Vuilleumier et al., 2002; Vuilleumier et al., 2001). These methods are chosen due to the automatic nature of emotion perception which occurs even in the absence of controlled cognitive input (i.e., conscious identification). The present study used degraded images with no real restrictions on exposure time or locus of attention. This method may have led participants to process the stimuli analytically, which may have had confounding effects on the automatic nature of valence perception and the feeling of familiarity. Indeed, Whittlesea and Price (2001) posit that the use of an analytic approach, such as scrutinizing test stimuli for recognizable features, regardless of whether it leads to recognition, prevents the overall experience of fluency and thus familiarity. In this vein, the use of obscured images of complex scenes in the present study may be inherently more vulnerable to analytic processing in general when compared with stimuli that may be processed more holistically, such as faces or words. Future research should investigate whether this has a meaningful effect on RWI.

Second, we found that when emotional images are unidentifiable under a visual noise filter, positive images were rated as more familiar than negative images. This effect appears to be robust and was present across three different filter intensities and three different image sets. Importantly, these findings were independent of arousal, providing novel evidence that valence alone can be utilized to make judgments about the familiarity of an image even if the image cannot be identified. Although this finding is contrary to a previously reported experiment using similar methods (Cleary et al., 2013), our results are consistent with a multitude of studies that have shown a strong link between familiarity and positive affect (Monin, 2003; Reber et al., 1998; Westerman et al., 2015; Whittlesea, 1993; Winkielman et al., 2003). In fact, the present result could be viewed as the flip side of the mere exposure effect (Zajonc, 1968). In the mere exposure effect, familiarity with a stimulus leads to a sense of positivity. Here, a sense of positivity is accompanied by a sense of familiarity even for stimuli that are unidentifiable.

Our results are at odds with the findings of Cleary et al. (2013), and important methodological differences may have accounted for this. In particular, a corrigendum of the original article was published recently that reveals a key difference between our methods and those of Cleary et al. Although the original article described the ratings as familiarity ratings, it appears that the instructions given to participants actually conflated familiarity and threat. As the authors note, “participants in Experiment 3 were instructed to judge the familiarity/likely threateningness of the image, with the emphasis in the trial-by-trial prompts placed on attempting to detect threat. Accordingly, these ratings are better described as threat likelihood ratings (or simply as ratings throughout the text), than as familiarity ratings” (Cleary et al., 2022, p. 1124). As described in our methods sections, participants in the present study were not told anything regarding threat, although they were made aware that some of the underlying images may be disturbing. If participants were instructed to conflate familiarity and threat, then it is more understandable why they would judge the negative images as more familiar. We suspect that these methodological differences go a long way toward explaining the differences in results between the two studies.

On the whole, our results are consistent with the view that familiarity and positive affect are assessed through largely automatic processes and suggest that they are so closely linked that conscious identification of the stimuli is not necessary for this link to manifest. A vague sense of familiarity may serve to guide us toward safety or favorable outcomes, in a sense that something “feels right” versus something “feels off.” The present experiments provide further evidence for the strong link between familiarity and affect, and the largely automatic nature of its categorization. Even when the content of an image is heavily obscured and cannot be identified, we are able to extract valence information, which appears to inform our impressions of the familiarity of a stimulus.

In Experiment 4, we found that this pattern of results held true independently of arousal. The distinction between the effects of valence versus arousal is vital in understanding the underlying mechanisms of judgments made on unidentifiable emotional stimuli, and by teasing the two apart, we found that regardless of arousal, participants can detect valence in unidentifiable images. An implication in this result, is that participants can use information about valence to make other types of judgments, such as threat, independent of arousal and conscious identification. However, this does not mean that arousal does not also affect participants’ judgments. Future studies should investigate the effect of arousal independent of valence, because participants may also be using arousal cues to make judgments on unidentifiable images, and valence and arousal may interact in important and meaningful ways.

Author note Both authors contributed to the conception and design of the experiments and the writing of the manuscript. S.D. performed the programming of experiments and data analysis.

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References

Arndt, J., Lee, K., & Flora, D. B. (2008). Recognition without identification for words, pseudowords and nonwords. *Journal of Memory and Language, 59*, 346–360. https://doi.org/10.1016/j.jml.2008.06.004

Balcetis, E., & Dunning, D. (2006). See what you want to see: Motivational influences on visual perception. *Journal of Personality and Social Psychology, 91*(4), 612–625.

Bolte, A., & Goschke, T. (2008). Intuition in the context of object perception: Intuitive gestalt judgments rest on the unconscious activation of semantic representations. *Cognition, 108*(3), 608–616.

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*(2), 379–390.

Calvillo, D. P., & Hawkins, W. C. (2016). Animate objects are detected more frequently than inanimate objects in inattentional blindness tasks independently of threat. *The Journal of General Psychology, 143*(2), 101–115.

Claparède, E. (1911). *Recognition et moïté. Archives de Psychologie, 11*, 79–90.

Claypool, H. M., Hall, C. E., Mackie, D. M., & Garcia-Marques, T. (2008). Positive mood, attribution, and the illusion of familiarity. *Journal of Experimental Social Psychology, 44*(3), 721–728.

Cleary, A. M., & Greene, R. L. (2000). Recognition without identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*(4), 1063–1069.

Cleary, A. M., & Greene, R. L. (2001). Memory for unidentified items: Evidence for the use of letter information in familiarity processes. *Memory & Cognition, 29*, 540–545.

Cleary, A. M., & Greene, R. L. (2004). True and false memory in the absence of perceptual identification. *Memory, 12*, 231–236.

Cleary, A. M., & Greene, R. L. (2005). Recognition without perceptual identification: A measure of familiarity? *Quarterly Journal of Experimental Psychology, 58A*, 1143–1152.

Cleary, A. M., Konkel, K. E., Nomi, J. N., & McCabe, D. P. (2010). Odor recognition without identification. *Memory & Cognition, 38*, 452–460.

Cleary, A. M., Langley, M. M., & Seiler, K. R. (2004). Recognition without picture identification: Geons as components of the pictorial memory trace. *Psychonomic Bulletin & Review, 11*(5, 903), –908.

Cleary, A. M., Ryals, A. J., & Nomi, J. S. (2013). Intuitively detecting what is hidden within a visual mask: Familiar-novel discrimination and threat detection for unidentified stimuli. *Memory & Cognition, 41*, 989–999.

Cleary, A. M., Ryals, A. J., & Nomi, J. S. (2022). Correction to Cleary, A. M., Ryals, A. J., & Nomi, J. S. (2013). *Memory & Cognition, 50*, 1124–1130. https://doi.org/10.3758/s13421-022-01301-6

Cleary, A. M., Winfield, M. M., & Kostic, B. (2007). Auditory recognition without identification. *Memory & Cognition, 35*, 1869–1877.

Corneille, O., Monin, B., & Pleyers, G. (2005). Is positivity a cue or a response option? Warm glow vs evaluative matching in the familiarity for attractive and not-so-attractive faces. *Journal of Experimental Social Psychology*, (*41*, 4), 431–437.

de Vries, M., Holland, R. W., Chenier, T., Starr, M. J., & Winkielman, P. (2010). Happiness cools the warm glow of familiarity: Psychological evidence that mood modulates the familiarity-affect link. *Psychological Science, 21*(3), 321–328.

Diano, M., Celeghin, A., Bagnis, A., & Tamietto, M. (2017). Amygdala response to emotional stimuli without awareness: Facts and interpretations. *Frontiers in Psychology, 7*, 2029.

Esteves, F., Dimberg, U., & Ohman, A. (1994). Automatically elicited fear: Conditioned skin conductance responses to masked facial expressions. *Cognition & Emotion, 8*, 99–108.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.

Garcia-Marques, T., Mackie, D. M., Claypool, H. M., & Garcia-Marques, L. (2004). Positivity can cue familiarity. *Personality and Social Psychology Bulletin, 30*, 585–593.

Garcia-Marques, T., Mackie, D. M., Claypool, H. M., & Garcia-Marques, L. (2013). Once more with feeling! Familiarity and positivity as integral consequences of previous exposure. In C. Unkelbach & R. Greifeneder (Eds.), *The experience of thinking: How the fluency of mental processes influences cognition and behavior* (pp. 50–69). Psychology Press.

Gläscher, J., & Adolphs, R. (2003). Processing of the arousal of subliminal and supraliminal emotional stimuli by the human amygdala. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 23*(32), 10274–10282.

Goldinger, S. D., & Hansen, W. A. (2005). Remembering by the seat of your pants. *Psychological Science, 16*(7), 525–529.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*(5), 513–541.

Kensinger, E. A. (2004). Remembering emotional experiences: Contribution of valence and arousal. *Reviews in the Neurosciences, 15*, 241–251.

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1*(2), 99–113.

Kimura, Y., Yoshino, A., Takahashi, Y., & Nomura, S. (2004). Interhemispheric difference in emotional response without awareness. *Physiology & Behavior, 82*(4), 727–731.

Kostic, B., & Cleary, A. M. (2009). Song recognition without identification: When people cannot "name that tune" but can recognize it as familiar. *Journal of Experimental Psychology: General, 138*, 146–159.

Kurdi, B., Lozano, S., & Banaji, M. R. (2017). Introducing the Open Affective Standardized Image Set (OASIS). *Behavioral Research Methods, 49*(2), 457–470.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International Affective Picture System (IAPS): Affective ratings of picture and instruction manual* (Tech. Rep. A-6). University of Florida, Center for Research in Psychophysiology.

Langley, M. M., Cleary, A. M., Woods, J., & Kostic, B. (2008). Picture recognition without picture identification: A method for assessing the role of perceptual information in familiarity-based picture recognition. *Acta Psychologica, 127*, 103–113.

Libkuman, T. M., Otani, H., Kern, R., Viger, S. G., & Novak, N. (2007). Multidimensional normative ratings for the International Affective Picture System. *Behavior Research Methods, 39*(2), 326–334.

Litt, A., Reich, T., Maymin, S., & Shiv, B. (2011). Pressure and perverse flights to familiarity. *Psychological Science, 22*(4), 523–531.

Mack, A., & Rock, I. (1998). Inattentional blindness: Perception without attention. *Visual Attention, 8*, 55–76.

Merikle, P. M., Smilek, D., & Eastwood, J. D. (2001). Perception without awareness: Perspectives from cognitive psychology. *Cognition, 79*, 115–134.

Monin, B. (2003). The warm glow heuristic: When liking leads to familiarity. *Journal of Personality and Social Psychology, 85*(6), 1035–1048.

Morris, A. L., Cleary, A. M., & Still, M. S. (2008). The role of autonomic arousal in feelings of familiarity. *Consciousness and Cognition, 17*, 1378–1385.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology, 64*(5), 723–739.

New, J. J., & German, T. C. (2015). Spiders at the cocktail party: An ancestral threat that surmounts inattentional blindness. *Evolution and Human Behavior, 36*(3), 165–173.

Nummenmaa, L., Hyönä, J., & Calvo, M. (2006). Eye movement assessment of selective attentional capture by emotional pictures. *Emotion, 6*(2), 257–268.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*(3), 466–478.

Ohman, A. (2005). The role of the amygdala in human fear: automatic detection of threat. *Psychoneuroendocrinology, 30*(10), 953–958.

Pessoa, L., Japee, S., & Ungerleider, L. G. (2005). Visual awareness and the detection of fearful faces. *Emotion, 5*(2), 243–247.

Peynircioğlu, Z. (1990). A feeling-of-recognition without identification. *Journal of Memory and Language, 29*, 493–500.

Reber, R., Winkielman, P., & Schwarz, N. (1998). Effects of perceptual fluency on affective judgments. *Psychological Science, 9*(1), 45–48.

Titchener, E. B. (1910). *A textbook of psychology*. Macmillan.

Turnbull, O. H., & Evans, C. E. Y. (2006). Preserved complex emotion-based learning in amnesia. *Neuropsychologia, 44*, 300–306.

Vuilleumier, P., Armony, J. L., Clarke, K., Husain, M., Driver, J., & Dolan, R. J. (2002). Neural response to emotional faces with and without awareness: Event-related fMRI in a parietal patient with visual extinction and spatial neglect. *Neuropsychologia, 40*, 2156–2166.

Vuilleumier, P., Drivere, J., & Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron, 30*, 829–841.

Wang, Q., Cavanagh, P., & Green, M. (1994). Familiarity and pop-out in visual search. *Perception & Psychophysics, 56*(5), 495–500.

Westerman, D. L., Lanska, M., & Olds, J. M. (2015). The effect of processing fluency on impressions of familiarity and liking. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*(2), 426–438.

Whittlesea, B. W. A. (1993). Illusions of familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*(6), 1235–1253.

Whittlesea, B. W. A. (1997). Production, evaluation and preservation of experiences: Constructive processing in remembering and performance tasks. In D. Medin (Ed.), *The psychology of learning and motivation* (Vol. 37, pp. 221–264). Academic Press.

Whittlesea, B. W. A., & Price, J. R. (2001). Implicit/explicit memory versus analytic/nonanalytic processing: Rethinking the mere exposure effect. *Memory & Cognition, 29*(2), 234–246.

Winkielman, P., Schwarz, N., Fazendeiro, T., & Reber, R. (2003). The hedonic marking of processing fluency: Implications for evaluative judgment. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 189–217). Erlbaum.

Yonelinas, A. P., & Ritchey, M. (2015). The slow forgetting of emotional episodic memories: An emotional binding account. *Trends in Cognitive Sciences, 19*(5), 259–267.

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2), 1–27.

Open practices Data and stimuli used in all experiments are available on the Open Science Framework and can be found at the following link: https://osf.io/kwc9m/?view_only=00ff285ab6cd46e7a16f17808c80fc19

None of the present experiments was preregistered.