MATTER in Emotion Research: Spanish Standardization of an Affective Image Set

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Running title: MATTER: Affective Image Set

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Abstract

Pictures with affective content have been widely used in the scientific study of emotions from two main approaches. On the one hand, the dimensional theories claiming that affective experiences can be described according to a few fundamental dimensions such as valence and arousal. On the other hand, the discrete-category theories proposing the presence of a number of basic and universal emotions. Although it has been demonstrated that these two approaches are not mutually exclusive, the existing standardized affective picture databases have been created from the dimensional perspective, which entails important gaps for research focused on discrete emotions. The present work introduces MATTER, a new database composed by 540 pictures depicting disgusting, fearful, neutral, erotic, mirthful and incongruent contents, and provides normative values (total N = 368, mean =120.47 ratings/picture) in valence and arousal dimensions, as well as in discrete affective (disgust, fear, erotica and mirth) and cognitive (incongruence and interest) features. A tentative classification into discrete categories is presented and physical properties of each picture are reported. Our findings suggest that MATTER constitutes a modern and suitable set of affective images including for first time both mirth and incongruence related pictures. Additionally, it will allow the examination of affective and cognitive processes in fear/disgust and humor/incongruence fields.

Keywords: Picture database, Affective ratings, Disgust, Fear, Neutral, Erotic, Mirth, Incongruency, Humor

Introduction

The presentation of static pictures has been used to elicit emotions in psychological research settings for decades. There are some specific features that make this method the most widely employed for emotion induction and regulation. Thus, photographs can depict a broad range of semantic contents, and may be standardized allowing a good experimental control on terms of intensity or duration, being suitable to be utilized in multiple topics and designs of research, as diverse as subliminal emotional modulation (Ruiz-Padial and Vila, 2007) or moral cognition (Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005). In addition, a considerable amount of studies has provided experimental evidence based on varied measures, such as behavioral (e.g. reaction time) or multiple physiological responses (e.g. autonomic correlates or event related potentials). The capability of the pictures to produce emotional states is well established in thousands of studies, and it seems to be even far superior to the video clips (Uhrig et al., 2016).

Although a plausible strategy might be the creation of an own custom-made set of pictures according to the goal of each specific research, this approach might be biased by the researcher's ideas and hamper the comparison across studies besides consuming too much time. When possible, it seems preferred to use an already standardized affective pictorial database. To this extent, the International Affective Picture System (IAPS) was developed in the Center for the Study of Emotions and Attention (CSEA-NIMH, University of Florida, USA) in 1995, and since then many other affective picture databases have been provided to the scientific community. The IAPS was the first set of pictures being validated for research purposes, and it has had an important impact in the experimental study of emotions serving as a standard in the field for decades. The IAPS contains more than one thousand color photographs

depicting real aspects and situations in life with standardized norms in three dimensions (affective valence, arousal and dominance) obtained in different countries around the world (e.g. Deák, Csenki, & Révész, 2010; Lasaitis, Ribeiro, Freire, & Bueno, 2008; Moltó et al., 1999; Silva, 2011; Soares et al., 2015; Verschuere, Crombez, & Koster, 2001). Although the IAPS remains widely cited, there are some reasons that explain the emergence of additional standardized pictures sets: (1) the intensive use of the IAPS stimuli in the same lab may produce a lost in part of its emotional power; (2) the range of situations represented by the IAPS pictures is wide but the number of available stimuli within the same topic is too small to be able to design studies with a elevated number of trials; (3) most of the pictures are over one or two decades old, so their quality is poor, or they are unfortunately outdated and unsuitable for the contemporary generation. Some of these limitations have been addressed by the construction of new set of pictures, such as the EmoPics (Wessa et al., 2010), Geneva affective picture database (GAPED; Dan-Glauser, & Scherer, 2011), Nencki affective picture system (NAPS; Marchewka, Żurawski, Jednoróg, & Grabowska, 2014), EmoMadrid emotional pictures database (Carretié, Tapia, López-Martín & Albert, 2019) or the Open Affective Standardized Image Set (OASIS; Kurdi, Lozano, & Banaji, 2017), among others.

In addition, it is remarkable to mention that all these picture sets (i.e., IAPS, EmoPics, GAPED, NAPS, EmoMadrid and OASIS) have been specifically standardized according to the dimensional model of emotion, so most of them coincide in offering normative data in terms of affective valence (ranging from negative to positive) and arousal (ranging from relaxing to activating) but neglecting the categorical model of emotions, which in turn propose the presence of a number of basic and universal emotions such as happiness, anger, fear, disgust, and sadness (Ekman, Friesen, and Ellsworth, 1982). It has been demonstrated that these two approaches are not mutually

exclusive and there is at least an integrative model of emotion (Lang & Bradley, 2010) according to which the discrete emotions would be organized in a subordinated way around affective valence and arousal as two basic dimensions. In fact, some affective word databases have been normed from both dimensional and discrete perspectives of emotion (Ferré, Guasch, Martínez-García, Fraga, & Hinojosa, 2017; Fraga, Guasch, Haro, Padrón, & Ferré, 2018; Stadthagen-González, Ferré, Pérez-Sánchez, Imbault, & Hinojosa, 2018).

In an attempt to overcome this situation, on the one hand, Mikels et al. (2005) tried to classify 390 pictures from the IAPS (203 negative and 187 positive) into disgust, fear, sadness, amusement, awe, contentment and excitement categories. There were 263 out of the 390 stimuli that did not fit into any of those categories and that were labeled as blended or undifferentiated. Two main limitations have to be noted regarding this study. Firstly, the authors did not include erotic pictures, and secondly, the disadvantages of the IAPS described above are still applicable (e.g., poor photographic quality and outdated images). On the other hand, Riegel et al. (2016) could classify 368 out of 510 pictures from the NAPS into happiness, anger, fear, sadness, disgust and surprise categories (the resting 142 pictures were again classified as blended or undifferentiated). However, they did not include erotic pictures either. Finally, there are additional picture databases focused on specific emotions such as disgust (Haberkamp, Glombiewski, Schmidt, & Barke, 2017) or fear (Michałowski et al., 2017), as well as specific topics as food (Blechert, Meule, Busch, & Ohla, 2014; Miccoli et al., 2016), alcohol (Billieux et al., 2011) or smoking (Khazaal, Zullino, & Billieux, 2012). Indeed, the number of standardized sets of pictures for emotion research is having an exponential growth in recent years but important gaps still exist that need attention.

Thus, the amount of research on some discrete emotions is increasing in the last years but pictures for covering some specific topics are scarce. This is the case of experiments comparing physiological responses to disgust and fear stimuli. This topic has originated an important volume of literature in the last 10 years (e.g., Carretié et al., 2011; Ruiz-Padial et al., 2018; Schienle et al., 2005; Stark et al., 2007; van Hooff et al., 2013; Xu et al., 2016). Only pictures from IAPS and NAPS have been classified according to the discrete emotion that evoke (Mikels et al., 2005; Riegel et al., 2016); however, the number of pictures categorized as disgust or fear eliciting is too small (12 fear/31 disgust in IAPS and 11 fear/51 disgust in NAPS). In addition, although some standardized sets of stimuli focused on disgust-related pictures (Haberkamp, Glombiewski, Schmidt, & Barke, 2017), and fear-related pictures (Michałowski et al., 2017), have been recently built, their normative ratings are not comparable with each other and fear pictures have not been rated in a disgust scale.

In the opposite extreme of the dimension of affective valence, several discrete positive emotions, such as amusement, love, contentment, surprise or happiness are often included in the diverse lists made from the discrete perspective (e.g., Arnold, 1960; Ekman, Friesen, & Ellsworth, 1982; Fredrickson, 2013; Oatley & Johnson-laird, 1987; Plutchik, 1980). There is a clear imbalance in all taxonomies between the number of positive and negative emotions. Besides the lower number of positive emotions, it is remarkable the lack of consensus on the specific positive emotions proposed, which is also evident in the completely different positive categories that emerged from the classifications made by Mikel et al. (2005) and Riegel et al. (2016). Shiota et al. (2017) tried to overcome this situation by proposing a hierarchical model that differentiates between eight discrete positive emotions (liking/pleasure, contentment, pride, sexual desire, attachment love, nurturant love, amusement, awe) that would emerge from a

common ancestor (enthusiasm) mediating adaptive management of fitness-critical resources. Even when Shiota and colleague's proposal represents a step forward and recognizes the relevance of differentiating between discrete positive emotions, the lack of consensus on the proposed specific categories is still evident, besides the gap that experimental research on discrete positive emotions has suffered, what it may also calls into question their universality against their dependency upon individual and cultural differences. One factor that may have contributed to the existence of this lacuna in the positive emotion field is the fact that it is difficult or even impossible, in many cases, to prompt these emotions through standardized pictures. Indeed, the elicitation of most of those positive emotions require eliciting stimuli with a clear self-reference component that must be personalized for each participant or even by definition, as in the case of surprise, the stimuli have to be original. Mirth is an important positive emotion suitable to be elicited by standardized pictures that is receiving increased attention in scientific research contexts although it has not been included in any of the taxonomies of discrete emotions. Specifically, mirth has been defined as "the distinctive emotion that is elicited by the perception of humor" (Martin, 2007). The stimuli used to provoke mirth in experimental settings are strips, cartoons, jokes, video clips or comedies. All these stimuli are composed at least for two components that have the capacity of creating a context that will be solved in an unexpected and funny way. It is hard to find a static photograph of a real scene that evokes by itself a humor response. Perhaps this is the reason because, according to visual inspection, none of the existing set of standardized pictures contains mirth-evoking stimuli nor ratings on the mirth of their pictures. The incongruity resolution theory (Suls, 1972) is one of the most influential at this time, guiding most of the current research on the neural processes associated with humor. Despite the lack of consensus on whether the incongruity needs to be resolved (Shultz,

1974; Suls, 1972), or whether the resolution of the incongruity plays a minimum role (Martin, 2007; McGraw & Warren, 2010), there is a majority agreement that some kind of incongruity is necessary to elicit humor. From this perspective, the stimuli must be mirthful but also contain an incongruence component in order to prompt an emotion of mirth.

The aim of the present study was to develop a new database of pictures useful for research on disgust/fear and on mirth/incongruity fields assessed both on target discrete emotions, as well as valence and arousal dimensions. To this end, pictures on four emotional (disgust, fear, mirth and erotica) and two neutral categories (congruent and incongruent) were collected. The rationale for selecting these specific categories is that *mirth-evoking pictures* have not been included in any prior databases although humor research is an emerging area within positive psychology that claims for validated instruments for its scientific study. *Incongruent* but not mirthful pictures will help designing new experiments that would allow testing the incongruity theory acting as control for the cognitive component of mirth. In turn, *erotic pictures* are evaluated as highly pleasant and arousing stimuli, being therefore an excellent control for the affective component of mirth. Moreover, erotic pictures have been rated very differently by male and female, which has been somehow related to inherent disgust properties in this specific category (Bradley, Costa, & Lang, 2015). To avoid a response bias to the positive extreme of valence dimension, two of the more investigated negative emotions have been included: *disgust* and *fear*. In this line, we also aimed to complement prior literature with comparable norms for these two negative discrete emotions. Finally, we included a *neutral* (congruent) category as control condition for the rest of categories, especially relevant for the cognitive component of incongruent pictures. Consequently,

this new database provides comparable norms that would certainly allow designing further studies on mirth and on disgust/fear.

Method

Stimuli Selection

The database comprises 540 images selected according to the author's criteria in such a way that six categories were equally represented: disgusting, fearful, mirthful, incongruent, erotic and neutral (90 pictures per category). All the mirthful and the incongruent pictures were selected from the internet, and the rest of images were chosen either from the internet or other existing sets. Thus, the final sample of stimuli was composed by pictures extracted from the IAPS (N = 96: 21 disgusting, 22 erotic, 34 fearful, 19 neutral), the NAPS (N = 75: 14 disgusting, 40 erotic, 15 fearful, 6 neutral), the EmoMadrid (N = 91: 27 disgusting, 9 erotic, 17 fearful, 38 neutral), SFIP (N =18: 1 disgusting, 1 fearful, 16 neutral), GAPED (N = 16: 5 fearful, 11 neutral) and internet (N = 244: 27 disgusting, 19 erotic, 18 fearful, 90 mirthful, 90 incongruent). Text and comments included in some of the pictures selected from the internet were removed to leave only the pictorial aspects. All pictures were resized to a 1024 x 768 pixel size, and black borders were added when it was necessary in order to get this specific size. The stimuli from IAPS, NAPS, EmoMadrid, and GAPED, are available from the original authors. The identification of the exact pictures selected from those databases as well as from the rest of the stimuli included in MATTER is available at www4.ujaen.es/~erpadial/ for research to noncommercial use.

Participants

Initially, 409 university students belonging to different degrees and Universities (University of Jaén, University of Granada, University Jaume I, University Rey Juan Carlos) participated in the study, being rewarded with course credit for their

participation. A preliminary data analysis showed that many participants did not rate a high number of pictures or rated some properties with scores completely opposite to those given by the overall sample. For each participant, we calculated the number of responses too high or too low in relation to the average for each feature and each picture, according to a two-standard deviations criterion. For the analysis reported here, those participants who had more than 288 (20%) irregular scores (blank and/or out of range) out of the overall 1440 scores were excluded. According to this criteria, 41 participants were removed, leaving the final sample composed by 368 participants (N= 135 rated the pictures included in Set 1; N= 109 rated the Set 2; and N= 124 rated the Set 3). In addition, the ratio Male:Female was controlled to have a minimum of 1:2. In total, 132 males and 236 females participated in the study (details on gender and age of the participants that rated each set can be consulted in Table 1). Preliminary t-tests calculated for age differences between genders did not show significant effects for any of the three sets of pictures (see Table 1). The Ethics Committee Research of University of Jaén approved the experimental protocol, and written informed consent was obtained from all participants prior to the study.

Table 1. Number, gender and age (mean and standard deviation) of the participants that rated every set of images, and t-values for age comparisons between genders.

		N	Mean Age (SD)	Ratio (female/male)	t-values (p-values)*
IMAGE SET 1	Female	88	20.87 (2.51)		
	Male	47	21.51 (2.47)		
	Total	135	21.09 (2.51)	1.87	-1.41 (0.16)
IMAGE SET 2	Female	70	20.41 (1.94)		
	Male	39	21.44 (3.38)		
	Total	109	20.78 (2.58)	1.79	-1.73 (0.09)

IMAGE SET 3	Female	78	21.03 (3.24)		
	Male	46	21.98 (3.09)		
	Total	124	21.38 (3.21)	1.70	-1.60 (0.11)

**Equal variances (non-significant Levene Test) have been assumed*

Procedure

The whole database (540 pictures) was divided in three sets of 180 pictures each one (30 from each emotional category). For each set of pictures four orders of presentation were semi-randomly created, with the constraint that no more than two stimuli of one category were presented in succession. Each picture was presented on a full screen for 1 second (see Figure 1 for a schematic representation of a typical trial). In a prior pilot study, it was observed that with practice participants became familiar with the procedure and began to respond faster. Therefore, in the final procedure it was decided to leave 26 seconds (for the first 15 pictures) and 15 seconds (for all other images) as the maximum time to evaluate each picture in a paper and pencil form including the rating scales for the 8 properties: two emotional aspects according to the dimensional perspective (valence and arousal), four emotional features according to the categorical perspective of emotions (disgust, fear, erotic and mirth), and two cognitive attributes (incongruence and interest). In all cases the scale ranged from 1 to 9, where 1 meant unpleasant, relaxing, not disgusting, not fearful, not erotic, not mirthful, not incongruent and not interesting at all, whereas 9 meant highly pleasant, arousing, very disgusting, very fearful, very erotic, very mirthful, very incongruent and very interesting (for valence, arousal, disgust, fear, erotica, mirth, incongruence and interest, respectively). One second before the presentation of each picture a tone was presented as a warning signal making the participants look at the screen in order to not miss any picture. All the ratings were collected in group sessions with a maximum of 30 participants which

received instructions, making sure that the meaning of the rating scales and the procedure was understood. The study began with three test trials followed by the 180 pictures of one of the three sets presented in 12 blocks of 15 pictures each according to four randomization orders. Each block was followed by a 9 seconds break in order to avoid fatigue in the participants. The overall task lasted for a maximum of 1-hour duration. After completing the experimental session, participants were thanked and received the corresponding course credit.

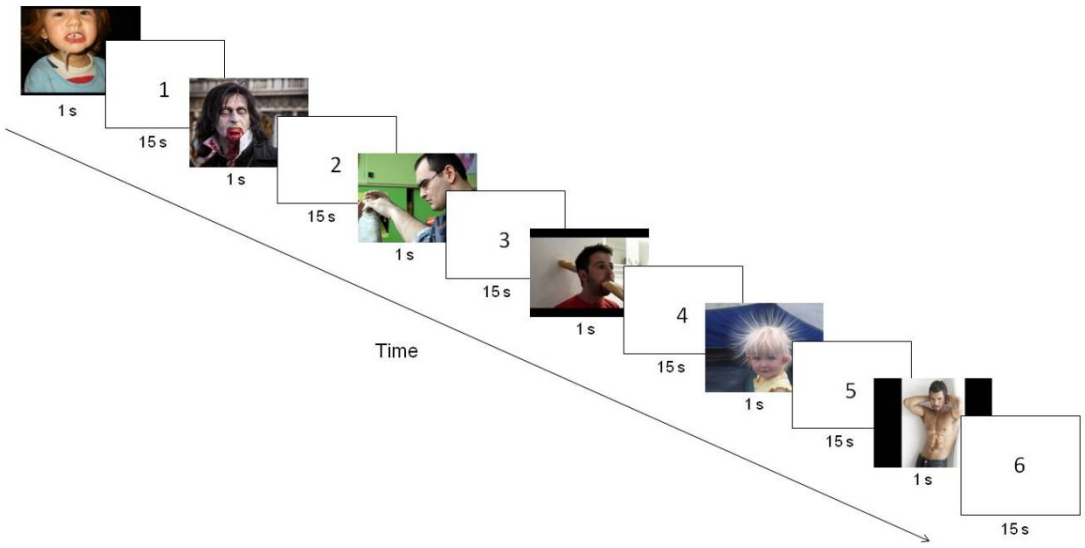

Figure 1. Schematic representation of a trial. Examples of pictures belonging to each category (disgust, fear, neutral, incongruent, mirth and erotica) are included. s= seconds

Results

Ratings

Ratings from 120.47 participants as average were collected for each picture (132.35 for pictures in Set 1, 107.13 in Set 2, 121.92 in Set 3). Mean and standard deviation for the ratings in valence, arousal, disgust, fear, mirth, erotica, interest and incongruence were calculated for each individual picture for the overall sample and for men and female separately. Data may be helpful for researchers in selecting stimulus material and it can

be consulted in Table S1 (Supplementary material available at www4.ujaen.es/~erpadial/).

Classification into discrete categories

The pictures included in the study were selected as belonging to the following discrete categories: disgust, fear, mirth, incongruent, erotica and neutral. In order to investigate the categorical structure of the selected set of pictures based on the empirical data, the same procedure of Mikels et al., (2005) was applied to identify images that elicit one discrete emotion more than others. Thus, means for the ratings in the five characteristics (disgust, fear, erotica, mirth and incongruence) related to the quality of the discrete emotions that constitute the main aim of the current study were calculated individually for each image. Although incongruence is not an affective feature and will not constitute an emotional but a cognitive category, in order to improve the readability of the present section it will be treated as one more emotional category. A 90% confidence interval (CI) was constructed around each mean and it was used to determine the category membership of every individual picture in such a way that if the mean for one characteristic was higher than the means of all the other ratings, and if the CI for that characteristic did not overlap with the CIs for the other four ratings, it was classified within a single discrete category. If two, three or four means were higher than the rest, and if the CIs of those means overlapped only with each other, the image was categorized as blended. Finally, if all five CIs overlapped, such an image was classified as undifferentiated.

According to this procedure, pictures were classified into one of the following categories: disgust, fear, erotica, mirth, incongruence, blended or undifferentiated. However, the initial selection of pictures considered also the inclusion of neutral

images. It has been difficult to find an objective criterion to classify pictures as neutral. To our knowledge, only two studies have applied a similar design to the current one by classifying emotional pictures into discrete categories and also collecting ratings on dimensional aspects (valence and arousal). Whereas Mikels et al (2005) worked with negative and positive but not with neutral pictures, Riegel et al. (2016) classified pictures as neutral following a dimensional criteria (valence values ranging from 4 to 6), but according to a discrete criteria the same set of pictures was divided into eight categories that did not include a neutral one (happiness, anger, sadness, fear, disgust, surprise, blended and undifferentiated). Therefore, none of previous studies has considered neutral pictures as a discrete category itself for comparison of discrete emotional images, as we expect to do here. To consider pictures as neutral in the current set of data, the same dimensional criteria used by Riegel et al. (2016) was applied on the pictures that met two conditions: they did not elicit a single discrete emotion, and the mixed emotion that elicit must be of low intensity. Thus, blended or undifferentiated pictures with mean values lower than 4 in the elicited target emotions, and whose valence ratings ranged between 4 and 6 were classified as neutral. Accordingly, overlapping between neutral and other discrete categories was avoided.

The results of this analysis yielded eight categories: disgusting, fearful, mirthful, incongruence, erotica, neutral, blended and undifferentiated. As can be observed in Table 2, in most of the discrete categories the Ns are around 30 in every image set, except for fearful and neutral pictures, where the Ns are lower. Moreover, a new category of blended pictures, not considered in the original design, emerged. As described before, pictures were considered blended when they could not be classified within a single category and received similar ratings in two, three or four discrete

features. This means that the label "blended" may cover pictures depicting very different content (see Table 3).

Table 2. Discrete categories and number of pictures included into each one after applying CI and conservative methods of classification.

		Disgust	Fear	Mirth	Incongruence	Erotica	Neutral	Blended	Undifferentiated
Set 1	*CI*	33	17	26	30	28	17	29	
	Conservative	22	3	11	10	16			
Set 2	*CI*	33	13	28	29	29	18	29	1
	Conservative	19	2	6	9	22			
Set 3	*CI*	33	16	33	27	28	22	21	
	Conservative	20	4	13	7	19			
TOTAL	*CI*	99	46	87	86	85	57	79	1
	Conservative	61	9	30	26	57			

Table 3. Combinations of different emotional contents included under the label "Blended" and number of blended pictures into each combination.

	M & I	D & F	D & I	D & I & F	D & I & M	F & I	E & M & I	TOTAL
Set 1	17	6	1	1		2	2	29
Set 2	11	10	2	5	1			29
Set 3	10	9		1		1		21
TOTAL	38	25	3	7	1	3	2	79

* Note: D = Disgusting, E= Erotic, F = Fearful, M = Mirthful, I = Incongruent

The visual inspection of the pictures included in each discrete category (disgust, fear, mirth, incongruence, erotica and neutral) generated doubts about the efficiency of the CI procedure to classify a few images. Indeed, after applying the CI method to the current ratings, some pictures selected from other datasets as belonging to one specific category were classified into a different one here (for example, neutral pictures in NAPS resulted as disgusting or mirthful pictures in the current data). A similar confusion applied for pictures classified as neutral that had a clear erotic or mirthful content.

Hence, although the CI based procedure seems to be the preferred method according to the literature to classify pictures into discrete categories, both Mikel et al. (2005) and Riegel et al. (2016) referred to alternative methods based on the mean ratings: (1) a liberal criteria that assign to each discrete category those pictures that received the higher mean rating in that particular discrete emotion compared to the other emotions; and (2) a conservative method that assign to a discrete category those pictures whose mean rating in one specific emotion was more than one standard deviation higher than the ratings for the other discrete emotions. Despite none of these mean-based-methods is suitable to identify potentially neutral pictures (since scores in a "neutral" scale were not collected), the conservative method was applied to the current data to complement the classification made following the CI method. The number of images assigned to each discrete category through the conservative procedure was smaller compared to the CI method (see Table 2), especially for fear eliciting pictures that were reduced in an 80.44%, followed by incongruent (69.77%), mirthful (65.52%), disgusting (38.38%) and erotic (32.94%) pictures. In addition, this procedure does not allow classifying pictures as neutral but eliminates the problem of the classification of images into erroneous categories.

The resulting categorical classification for each image through both methods is included in Table S1 of the Supplementary material. The mean values in valence and arousal for each discrete category according to the CI and the conservative method are shown in Tables 4 and 5, respectively. Figure 2 represents the pictures classified according to the CI (A) and the conservative method (B), respectively according to the affective space formed by their averaged valence and arousal ratings. After comparing both classifications, the conservative method seemed too strict as resulted in too few pictures per category, with a remarkable reduction of fearful images, and importantly, did not allow creating a neutral category.

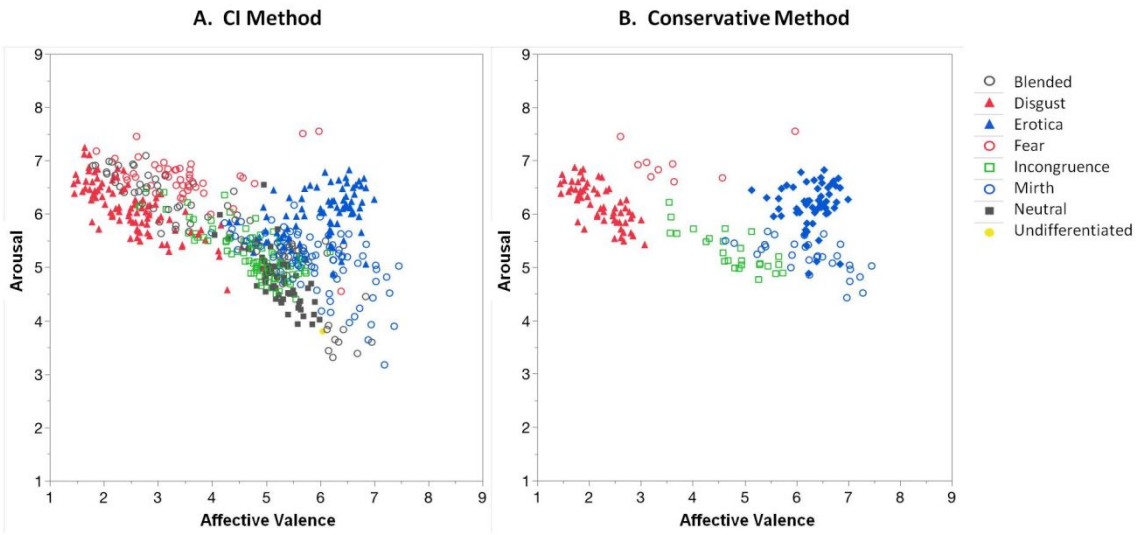

Figure 2. Pictures in the affective space formed by their averaged valence and arousal ratings (classified according to the CI (A) and the conservative method (B)).

Table 4. Mean values (and standard deviations) in valence and arousal dimensions for pictures included in each discrete category according to the CI method.

		Disgust	**Fear**	**Mirth**	**Incongruence**	**Erotica**	**Neutral**	**Blended**	**Undifferentiated**
Valence	*Set 1*	2.548 (1.64) (Range: 1.48-4.28)	3.351 (1.89) (Range: 2.20-5.98)	5.766 (1.58) (Range: 4.54-7.45)	4.571 (1.56) (Range: 2.65- 5.74)	5.924 (1.72) (Range: 4.77-6.78)	5.225 (1.21) (Range: 4.30-5.90)	4.658 (2.16) (Range: 1.80-6.95)	-
	Set 2	2.556 (1.72) (Range: 1.44-4.16)	3.524 (1.87) (Range: 1.86-5.68)	5.923 (1.72) (Range: 3.99-7.23)	4.723 (1.58) (Range: 3.15- 6.18)	6.140 (1.75) (Range: 4.99- 7)	5.277 (1.21) (Range: 4.93-5.99)	3.861 (2.11) (Range: 1.84-6.43)	6.048 (1.64)
	Set 3	2.121 (1.47) (Range: 1.61-4.97)	3.619 (1.99) (Range: 2.43-6.39)	5.886 (1.69) (Range: 4.37-7.37)	4.838 (1.46) (Range: 2.79- 5.72)	5.928 (1.80) (Range: 4.32-6.85)	5.208 (1.41) (Range: 4.05-5.89)	3.976 (2.02) (Range: 2.05-6.16)	-
	TOTAL	2.549 (1.68) (Range: 1.44-4.97)	3.487 (1.92) (Range: 1.86-6.39)	5.857 (1.66) (Range: 3.99-7.45)	4.701 (1.54) (Range: 2.65- 6.18)	5.991 (1.75) (Range: 4.32- 7)	5.233 (1.29) (Range: 4.05-5.99)	4.214 (2.14) (Range: 1.80-6.95)	6.048 (1.64)
Arousal	Set 1	6.111 (1.47) (Range: 4.57-7.24)	6.703 (1.47) (Range: 5.99-7.55)	5.218 (1.50) (Range: 4.08-6.16)	5.384 (1.35) (Range: 4.50- 6.40)	5.893 (1.58) (Range: 5.09-6.61)	4.762 (1.31) (Range: 3.93-	5.360 (1.85) (Range: 3.31-6.90)	-

							5.53)		
	Set 2	6.080 (1.55) (Range: 5.29- 6.87)	6.703 (1.55) (Range: 5.99- 7.50)	5.108 (1.64) (Range: 3.64-5.94)	5.253 (1.33) (Range: 4.40- 6.08)	5.959 (1.76) (Range: 4.88- 6.58)	4.823 (1.37) (Range: 3.93- 5.71)	5.816 (1.74) (Range: 3.44- 6.97)	3.798 (1.73)
	Set 3	6.112 (1.60) (Range: 4.99- 7.11)	6.535 (1.64) (Range: 4.55- 6.94)	5.019 (1.66) (Range: 3.17- 5.72)	5.167 (1.36) (Range: 4.72- 6.47)	6.061 (1.69) (Range: 5.06- 6.82)	4.734 (1.51) (Range: 4.08- 6.55)	5.947 (1.63) (Range: 3.91- 7.09)	-
	TOTAL	6.102 (1.54) (Range: 4.57- 7.24)	6.645 (1.55) (Range: 4.5- 7.55)	5.109 (1.61) (Range: 3.17- 6.16)	5.2276 (1.35) (Range: 4.40- 6.47)	5.969 (1.67) (Range: 4.88- 6.82)	4.768 (1.41) (Range: 3.93- 6.55)	5.667 (1.78) (Range: 3.31- 7.09)	3.798 (1.73)

Table 5. Mean values (and standard deviations) in valence and arousal dimensions for pictures included in each discrete category according to the conservative method.

		Disgust	**Fear**	**Mirth**	**Incongruence**	**Erotica**
Valence	*Set 1*	2.303 (1.48) (Range: 1.48 – 3.01)	4.276 (2.15) (Range: 3.19 – 5.98)	5.677 (1.65) (Range: 4.63 – 7.45)	4.749 (1.68) (Range: 3.55 – 5.74)	6.115 (1.73) (Range: 5.43 – 6.78)
	Set 2	2.118 (1.47) (Range: 1.44 – 3.07)	2.858 (1.58) (Range: 2.61 – 3.11)	6.506 (1.61) (Range: 5.33 – 7.23)	4.646 (1.66) (Range: 3.56 – 5.60)	6.417 (1.66) (Range: 5.14 – 7)

	Set 3	2.186 (1.49) (Range: 1.61 – 2.72)	3.614 (1.98) (Range: 2.94 – 4.57)	6.318 (1.64) (Range: 5.24 – 7.28)	4.972 (1.32) (Range: 4.59 – 5.66)	6.335 (1.67) (Range: 5.56 – 6.85)
	TOTAL	2.215 (1.48) (Range: 1.44 – 3.07)	3.705 (2.04) (Range: 2.61 – 5.98)	6.217 (1.65) (Range: 4.63 – 7.45)	4.781 (1.58) (Range: 3.55 – 5.74)	6.295 (1.69) (Range: 5.14 – 7)
Arousal	*Set 1*	6.166 (1.45) (Range: 5.59 – 6.74)	6.950 (1.57) (Range: 6.60 – 7.55)	5.330 (1.54) (Range: 5.02 – 5.61)	5.388 (1.45) (Range: 4.89 – 6.21)	6.175 (1.62) (Range: 5.11 – 6.61)
	Set 2	6.256 (1.59) (Range: 5.42 – 6.87)	7.206 (1.45) (Range: 6.96 – 7.45)	5.196 (167) (Range: 4.82 – 5.62)	5.267 (1.30) (Range: 4.88 – 5.64)	6.08 (1.81) (Range: 4.88 – 6.58)
	Set 3	6.165 (1.56) (Range: 5.49 – 6.84)	6.840 (1.53) (Range: 6.67 – 6.94)	5.096 (1.74) (Range: 4.43 – 5.67)	5.147 (1.34) (Range: 4.77 – 5.72)	6.233 (1.78) (Range: 5.06 – 6.82)
	TOTAL	6.190 (1.53) (Range: 5.42 – 6.87)	6.951 (1.54) (Range: 6.60 – 7.55)	5.205 (1.66) (Range: 4.43 – 5.67)	5.275 (1.37) (Range: 4.77 – 6.21)	6.162 (1.75) (Range: 4.88 – 6.82)

Reliability

The internal consistency of participant evaluations was estimated by calculating split-half reliability scores (Wierzba et al., 2015). To this end, participants were numbered according to their order of participation and each sample that evaluated one of the three sets of pictures was split into two groups (i.e., odd vs. even participant numbers). The average ratings for valence, arousal, disgust, fear, erotica, mirth, incongruence and interest were then calculated separately, for each image and within each participant group. Finally, Pearson correlations among these average ratings were calculated for the two groups of participants of each sample. All correlations were significant ($p < 0.001$),

and Spearman-Brown corrected reliability scores were high for the three sets of pictures (Valence: r = 0.995, r = 0.994, r = 0.988; Arousal: r = 0.989, r = 0.976, r = 0.977; Disgust: r = 0.996, r = 0.996, r = 0.992; Fear: r = 0.994, r = 0.997, r = 0.957; Erotica: r = 0.998, r = 1, r = 1; Mirth: r = 0.997, r = 0.996, r = 0.993; Incongruence: r = 0.993, r = 0.992, r = 0.992; Interest, r = 0.982, r = 0.986, r = 0.972; for Set 1, 2 and 3, respectively).

Gender differences

The effect of gender on the picture ratings was explored by calculating the mean of valence, arousal, disgust, fear, mirth, erotica, incongruence and interest ratings for each image, broken down by sex (see Table S1). The mean, standard deviation and range of the ratings in these eight features are presented in Table 6 for the overall sample, as well as for males and females separately.

Table 6. Mean (and standard deviations) in the eight features evaluated for the whole sample and for males and females separately.

	Males	Females	All participants
Valence	4.757 (2.00)	4.479 (2.18)	4.578 (2.12)
Arousal	5.604 (1.65)	5.643 (1.67)	5.629 (1.66)
Disgust	2.284 (2.30)	2.567 (2.65)	2.466 (2.53)
Fear	1.723 (1.71)	1.945 (2.09)	1.865 (1.97)
Mirth	2.665 (2.47)	2.463 (2.46)	2.536 (2.47)
Erotica	1.777 (2.01)	1.763 (1.99)	1.768 (1.99)
Incongruence	2.916 (2.68)	2.926 (2.78)	2.922 (2.75)
Interest	3.627 (2.50)	3.040 (2.43)	3.251 (2.47)

* Ranges were 1-9 for all ratings in all participants and for both males and females separately

Correlations were applied and results showed that assessments by men and women were highly positively correlated for all the features measured in this study (valence (r = 0.925), arousal (r = 0.88), disgust (r = 0.976), fear (r =0.973), mirth (r =0.969), erotica (r =0.911), incongruence (r =0.969), interest (r =0.755), all *ps* < 0.001).

As in previous studies, the distribution of the emotional pictures in the bidimensional affective space was similar for males and females (see Figure 3). Similarly, the results regarding the quadratic correlation between valence and arousal both for males (r = 0.565, p < .001) and females (r = 0.629, p < .001), although slightly lower, was comparable to other emotional pictures adapted to Spanish samples (for example, Moltó et al. (1999) reported .61 and .65 for men and women, respectively).

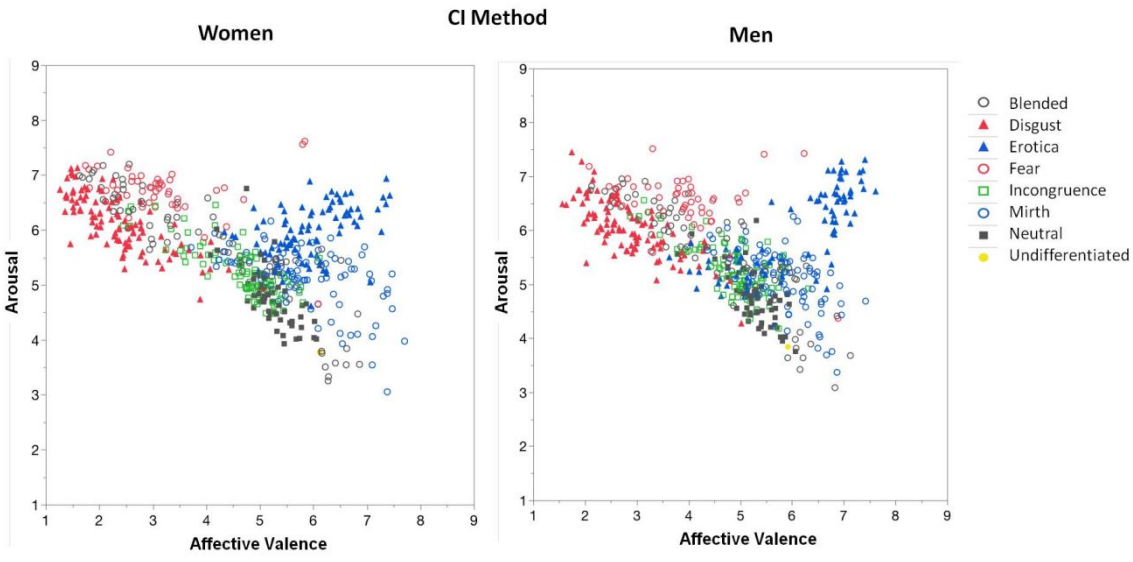

Figure 3. Pictures in the affective space formed by their averaged valence and arousal ratings (classified according to the CI method), for women and men separately.

Physical properties of images

The luminance, contrast, mean channel values in CIE 1976 L*a*b color space, spatial frequency in nine different bands, and size of each image were also calculated and listed in Table S2 (Supplementary material available at www4.ujaen.es/~erpadial/).

Luminance was defined as the average pixel value, and the contrast was defined as the standard deviation across all pixels of the grayscale image (as, for example, in Haberkamp et al., 2017; and in Marchewka et al., 2014). Mean channel values in CIE 1976 L*a*b color spaces were obtained by converting RGB values to color space values and computing the mean of each channel. As CIE 1976 L*a*b is a color-opponent space, it approximates characteristics of the human visual system with the L* dimension corresponding to lightness (range: 0-100) and two color-opponent dimensions corresponding to green (negative values)-red (positive values) range the a* dimension, and to blue (negative values) - yellow (positive values) range the b* dimension (Marchewka et al., 2014). These physical properties of each image were computed with the ImageJ program (version 1.52a; Rasband, 1997-2018). JPEG size has been proposed to be a good index of the overall complexity of an image since it correlates with subjective measures of image complexity (Donderi, 2006). With respect to spatial frequency, spectral energies were computed for nine frequency bands (768-384 pixels/cycle or p/c, 384-192 p/c, 192-96 p/c, 96-48 p/c, 48-24 p/c, 24-12 p/c, 12-6 p/c, 6-3 p/c and residuals) within each picture, including the black margins that some of them needed in the vertical or the horizontal dimension to fit the 1024 x 768 pixel format. Analyses were carried out following the procedure described by Delplanque et al. (2007) in which the gray 709 option was selected (see also Carretié et al., 2019). The JPEG size of the color images was determined with a compression quality setting of

80% using FastStone Photo Resizer (version 3.9; https://www.faststone.org/) for JPEG compression.

Discussion

The current study presents MATTER, a database of pictures depicting disgusting, fearful, erotic, mirthful and incongruent contents. All the pictures have been normed in valence and arousal dimensions, as well as in discrete emotional (disgust, fear, erotica and mirth) and cognitive (incongruence and interest) features. Furthermore, MATTER is also the first database that includes mirth and incongruence related pictures, allowing therefore the design of future controlled studies in the humor research field, especially relevant for the incongruity resolution theory. Additionally, the physical properties of each picture are reported to provide complementary information that can help selection of images for future research designs. Finally, around half of the included pictures (45.18%) were not selected from prior existing databases, being carefully chosen to adjust to contemporary canons and avoid outdated images.

All these factors turn MATTER on a modern and suitable set of affective images that allows examining both affective and cognitive components in different important scientific fields of discrete emotion research such as fear/disgust and humor/incongruence. Notably, in the current database subjective ratings in four discrete emotions (disgust, fear, erotica and mirth) and two affective dimensions (valence and arousal) are provided for each picture, with the aim of allowing researchers to simultaneously select the stimuli according to both discrete and dimensional perspectives.

A classification of all pictures into one of the six categories considered in our original design (disgust, fear, erotica, mirth, incongruent and neutral) was carried out

based on the CI method, according to the mean scores assigned to each stimulus in five features: the four target emotions (disgust, fear, erotica, mirth) and the cognitive attribute of incongruence. The results revealed a number of pictures belonging to each discrete category in accordance with the initial design of the study (Ns around 30 pictures for each category in each image set) for disgust, mirth, incongruence and erotica categories. However, the Ns for fear and neutral categories were lower than expected. As a consequence, a new category of *blended* emotions (including pictures with diverse affective content) strongly emerged. The most frequent content in the blended category was a mixture of mirth and incongruence (48.10 %), followed by a mixture of fear and disgust (31.65 %). The rest of blended subcategories included few pictures and were composed by different combinations that always contained a mixture of incongruence and other emotional categories.

The high number of images experienced as equally incongruence and mirth eliciting seems to indicate the relevance of the incongruence for humor (in line with the incongruity resolution theories) and posit MATTER as a useful tool that will allow to investigate the role of the incongruence in mirth induction based on the selection of pure mirthful, pure incongruent and mixed mirthful/incongruent pictures. The relevance of cognitive factors may not be limited to incongruence and humor. Existing literature showed important differences between positive and negative emotions in their relationship with several cognitive processes (Madan, Scott, & Kensinger, 2019; Zinchenko, Obermeier, Kanske, Schröger, & Kotz 2017). Since the adaptive function of all positive emotions, not just mirth, are not linked to immediate threat for survival but rather to facilitate effective management of and response to opportunities, they might involve a more complex cognitive processing of the environment compared to negative stimuli. However, these are questions that future research will have to address.

The emergence of a rather large additional number of images prompting a blurred disgust/fear emotion along with a scarce number of "pure fear" eliciting pictures suggests two complementary hypotheses regarding the basic emotion of fear. One interpretation that has received attention in the last years would be that disgust has a strong participation in certain situations often labelled as fear-related (Knowles, Jessup, & Olatunji, 2019). Whereas it is frequently stated that fear is one of the most investigated negative emotions, the term "fear" is avoided in many publications on the topic (being usually preferred terms as "negative emotions", "threat" or "anxiety"). Many other studies have focused on phobic fear, which involve other components such as anxiety (e.g., social phobia) or disgust (e.g., spider, snake or blood-injection-injury phobias), additionally to the pure emotion of fear. Another plausible explanation is that it is especially difficult to prompt genuine fear in a safe context such as the laboratory settings. In this vein, Gross and Levenson (1995) reported decades ago that fear was one of the most difficult emotions to provoke viewing film clips. The scarce number of pictures classified as fearful in the current study, much like in Riegel et al. (2016)'s, seems consistent with this idea. One factor that may contribute to the difficulty to induce fear in safe contexts could be the strong role of motion in threatening stimuli as it occurs when a predator is approaching (Courtney, Dawson, Schell, Iyer, & Parsons, 2010). However, motion may be less relevant for inducing other negative emotions that are less dependent on danger proximity (e.g., disgust), or for eliciting positive emotions (e.g., mirth relying on a hilarious situation). Nonetheless, this is an open question that should be further explored in future research.

Similarly, the classification of pictures as neutral has not been generally addressed in previous research. Thus, neutral stimuli are supposed to be low emotionally charged (do not provoke intense negative or positive emotions), and

medium arousing (do not elicit extremely relaxing or arousing states), being therefore considered as a control condition in most of the studies focused on emotion induction and regulation. Previous pictorial databases that include neutral scenes have used a priori dimensional criteria (Dan-Glauser, & Scherer, 2011; Haberkamp et al., 2017; Michałowski et al., 2017), but do not subsequently verify whether these neutral pictures could be considered as such according to the subjective evaluations collected in their studies. Only Riegel et al. (2016) used the valence ratings from their participants to classify pictures as neutral according to the dimensional perspective (in which pictures are classified as negative, neutral or positive pictures). However, they did not include a neutral category among the discrete categories, so when comparing both dimensional and discrete classifications an important overlap could emerge. It is usually assumed that neutral pictures score in the mid-range of the hedonic valence scale. In our opinion, such criterion is not only nonspecific but may also cover a wide and heterogeneous range of semantic contents that are not necessarily neutral in terms of affect. In this regard, Haberkamp et al. (2017) found a mean valence score of 7.30 for neutral pictures, whereas Michałowski et al. (2017) reported a mean value of 6.14 (both in scales ranging from 1 = very negative/unpleasant to 9 = very positive/pleasant with 5 = neutral). In addition, it is worth noting that neutral stimuli have not traditionally been the focus of interest in emotion research but rather a mere control condition. However, the specific neutral stimuli used to compare with target categories can be decisive in a scientific scenario. In this sense, we expect that our study (both the methodology to classify the pictures and the neutral stimuli included in MATTER) can be regarded as a plausible contribution to the study of human emotions.

Finally, it should be considered that our stimulus classifications were made according to the CI procedure since it has been the preferred method in past research.

Nonetheless, none of the two methods used here for classifying the pictures into discrete emotional categories are free of limitations. Whereas one seems a bit relaxed, the other seems to be too strict. The results from both classifications are offered in this work, so that the researchers can decide which one fits better to their own goal. Moreover, as data for each image across all ratings are available, alternative methods to classify pictures into discrete categories to the presented here can be used. Similarly, the pictures could be simply selected based on their mean scores in the features or dimensions of interest.

In line with previous findings (Haberkamp et al., 2017; Kurdi et al., 2017), subjective ratings of men and women were highly correlated for all affective measures. However, these results differ from those reported in Spanish population by Moltó et al. (1999) and Vila et al. (2001), as higher arousal ratings were found for women compared to men. On other hand, Redondo et al. (2007) also obtained strong correlations between men and women both for valence and arousal ratings in their Spanish adaptation of the ANEW (Affective Norms for English Words), replicating the gender differences previously found for pictures (Moltó et al., 1999; Vila et al., 2001). Indeed, findings regarding gender differences in valence and arousal subjective ratings in samples from other countries are mixed. While no gender differences were reported in several studies (e.g., Billieux et al., 2011; Khazaal et al., 2012; Kurdi et al., 2017), other works found a main gender effect either in valence (Bradley et al., 2001; Haberkamp et al., 2017; Miccoli et al., 2016) or arousal ratings (Bradley et al., 2001). In order to understand what may be contributing to these inconsistencies, variables such as the specific content of the pictures could be explored. Data from MATTER would allow the analysis of gender differences in pictures belonging to different discrete emotional categories, as well as to explore the contribution of other specific features (beyond valence and

arousal). Further research could address this relevant issue that transcend the scope of the current research.

Notwithstanding, our study has certain limitations that should be addressed in future investigations. On the one hand, there is a considerable number of outliers, probably due to the elevated number of pictures rated by each participant and the short period of time to rate each picture in eight different features. Despite this limitation, our design was similar to prior ones in terms of the number of pictures per session (Carretié et al., 2019; Dan-Glauser, & Scherer, 2011), and even other studies included higher number of pictures per session (Marchewka et al., 2014). However, these factors must be certainly considered because of its plausible influence on fatigue, decision process, or simply on the commission of errors. On the other hand, sexual orientation of participants should have been requested since it could be relevant for the ultimate statistical analysis and interpretation of findings concerning erotic images, as stated in previous works (Wierzba et al., 2015). Finally, we must acknowledge that our experimental sample was quite homogeneous in some demographic variables (such as age and education), which might limit the generalization of current results. Although this limitation would also involve previous works providing sets of affective pictures for either basic or clinical research purposes, it can be turned into a methodological advantage in terms of experimental rigor. Nevertheless, future research will have to explore in more detail the existence of gender differences (for example in the classification into discrete categories), in addition to plausible age and cross-cultural differences with other Spanish speaker countries in order to guarantee the generalization of the current results. Likewise, MATTER could be considered as a dynamic database that might be expanded in the near future by adding new images in order to broaden the spectrum of discrete emotions currently covered.

Despite the above limitations and methodological improvements that could be implemented over time, we should emphasize that MATTER adds to the current literature. Indeed, it constitutes a pictorial database composed by a wide number of fearful, disgusting, neutral, erotic, mirthful and incongruent images normed for the first time considering simultaneously both dimensional and discrete perspectives besides cognitive features, opening therefore new avenues for experimental designs.

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Author notes

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