

A study of dramatic action and emotion using a systematic scan of stick figure configurations

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Supplementary Information

Contents

Figure S1 Schematic snapshots of experiments 2 and 3	2
Figure S2 Percentage of images identified with DA or emotion for different thresholds	3
Figure S3 Ratios between the numbers of images identified with DA and with emotion	4
Figure S4 Number of words identified in an image.....	5
Figure S5 Participants who participated in both experiment 1 and 2 for the same images identified more DAs than emotions.....	6
Figure S6 Hierarchical clusters of the DA words according to the clustering of Figure 3	7
Figure S7 Correlations between word scores cluster into several main groups.....	8
Figure S8 Principal component analysis (PCA) of images identified with DA.....	9
Figure S9 Clustergram of all 1470 images according to raw median scores	10
Figure S10 A version of Figure 4 which displays the strongest DAs or emotions including those with scores lower than 50.....	11
Figure S11 A version of Figure 4 which displays the second strongest DAs or emotions with scores above 50.....	12
Figure S12 Snapshot of the SF dictionary	13
Figure S13 Examples of additional stick figures configurations for further studies	14
Table T1 Regression for predicting DAs given the scores for all emotions	15
Table T2 Regression for predicting emotions given the scores for all DAs	15

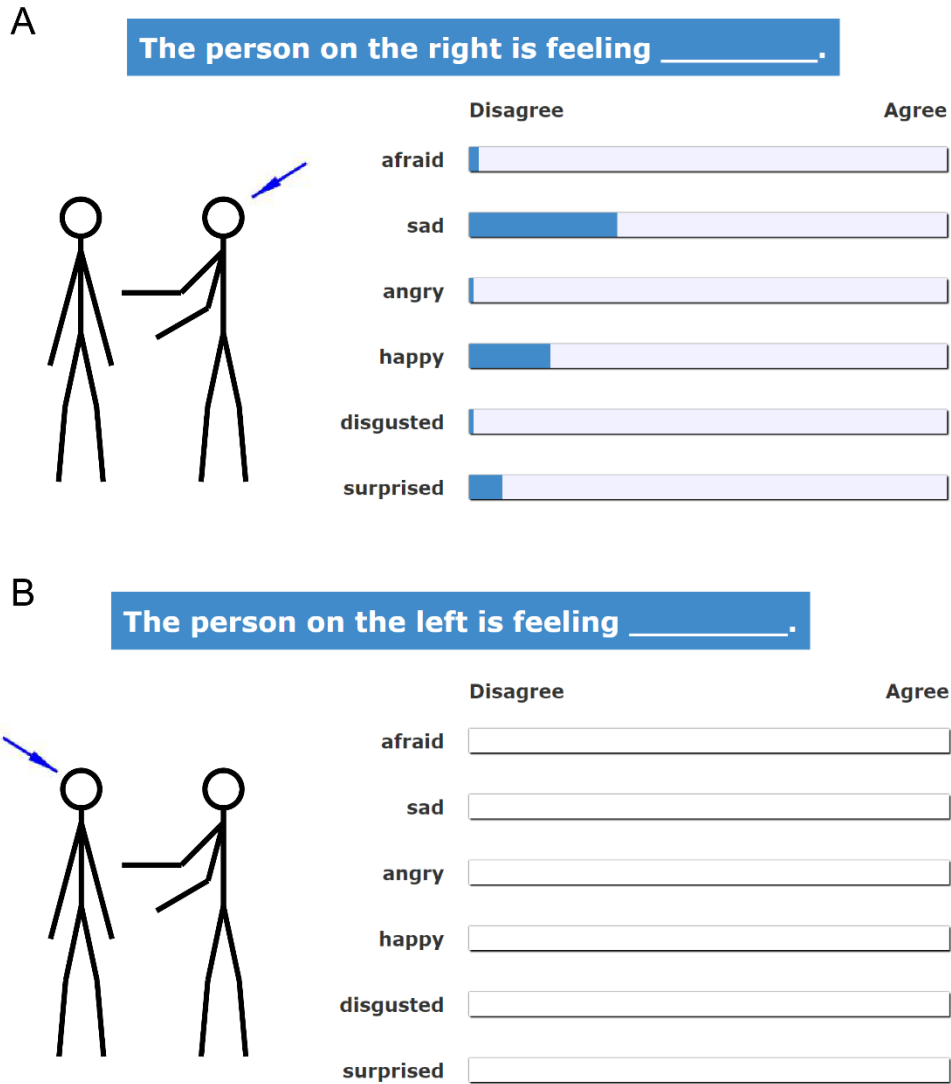


Figure S1 | Schematic snapshots of experiments 2 and 3

(A) Schematic representation of experiment 2, asking about the emotions of the right SF. (B) Example of survey design of experiment 2, testing the emotion of the left SF. Note the subtle color change of the slider scale after an answer is given by the participant (A) compared to the color at the initial state (B).

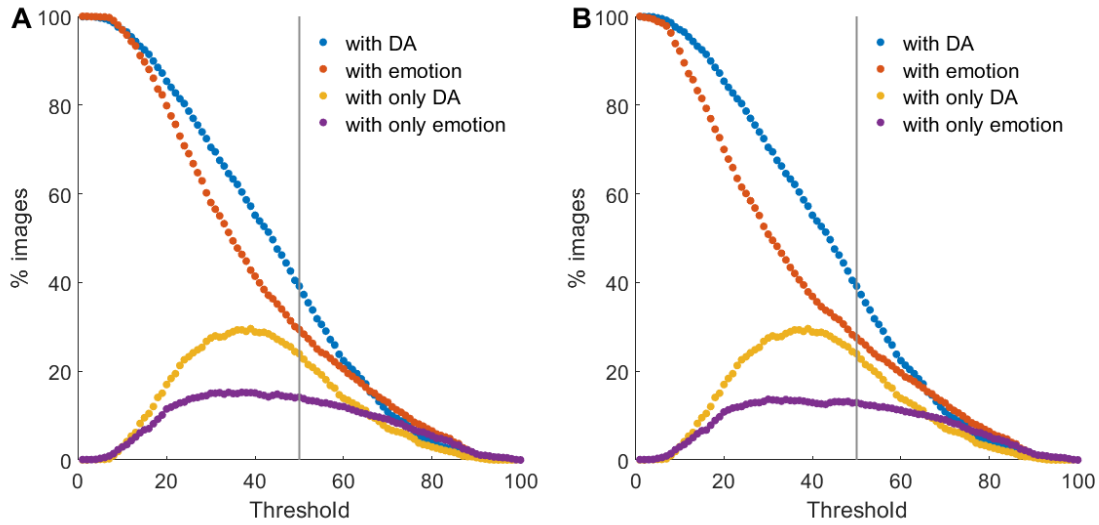


Figure S2 | Percentage of images identified with DA or emotion for different thresholds

(A) Percentage of images in which at least one DA or emotion received a median score higher than a threshold, as a function of the threshold. The gray line indicates the threshold of 50 used in the main text. (B) To control for the larger number of emotion words (twenty) than DA words (eight), we compared DA to the 8 emotion words that received the highest scores (angry, confused, surprised, contempt, embarrassed, compassion, triumph, sympathy). The behavior is qualitatively similar when using all 20 emotion words and when using the 8 top emotion words.

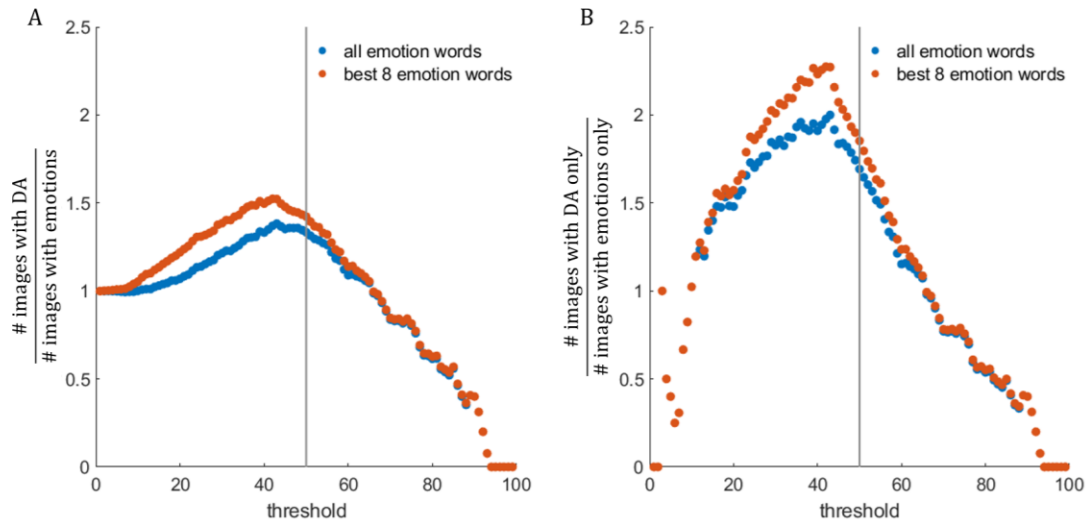


Figure S3 | Ratios between the numbers of images identified with DA and with emotion

(A) The ratio between the number of images identified with DA and the number of images identified with emotion as a function of the threshold (in the main text we used a threshold score of 50, gray line). To control for the smaller number of DA words (eight) than emotion words (twenty), we also used only the 8 emotion words most frequently found (orange). (B) The ratio between the number of images identified with DA without emotion and the number of images identified with emotion without DA for different thresholds.

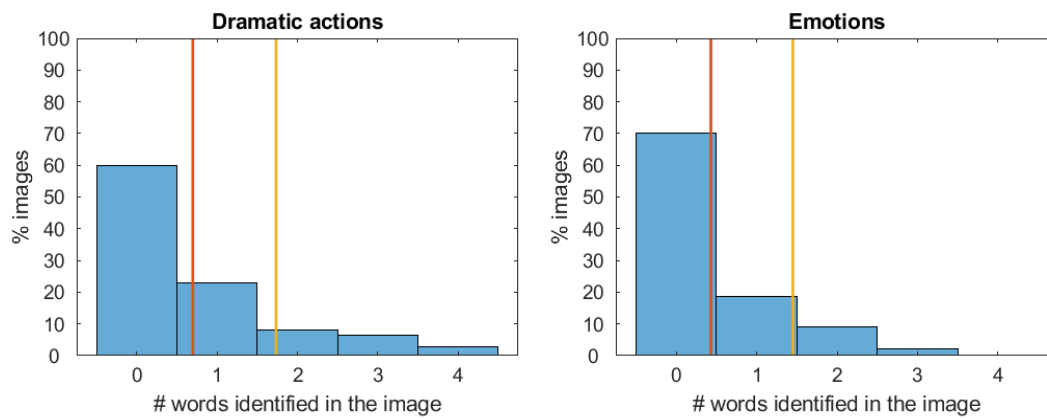


Figure S4 | Number of words identified in an image

Distribution of number of identified words per image for DA (left), and among the 20 emotions (right). The vertical lines show the mean number of words out of all images (orange) and the mean number of words out of images with at least one identified word (yellow).

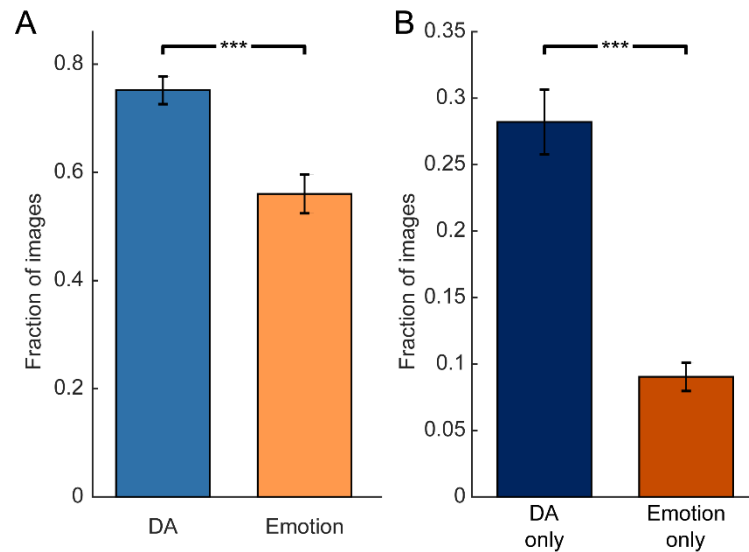


Figure S5 | Participants who participated in both experiment 1 and 2 for the same images identified more DAs than emotions

Sixty-eight participants were surveyed with the same images (14-98 images) in experiments 1 and 2. A word was counted as identified if the participant gave it a score of the 50 or higher. (A) The mean fraction of images identified with DA is 1.3 times higher than the mean fraction of images identified with emotion (One-sided paired t-test, $t(67)=6.64$, $p<10^{-8}$). (B) Mean fraction of images identified with at least one DA but no emotion is 3.1-fold larger than the mean fraction of images identified with at least one emotion but no DA (One-sided paired t-test, $t(67)=6.64$, $p<10^{-8}$). Note that the t-test statistic in A and B is the same because the columns in B are identical to those in A except that the same number was subtracted from both columns in B, namely the mean fraction of images identified with both DA and emotion. Noise plays a larger role in the present comparison than in the comparison in Fig. 2 in the main text for two reasons: the smaller number of participants in the present comparison and the use of a median over 20 participants in Fig. 2 versus a single-participant measure in the present comparison.

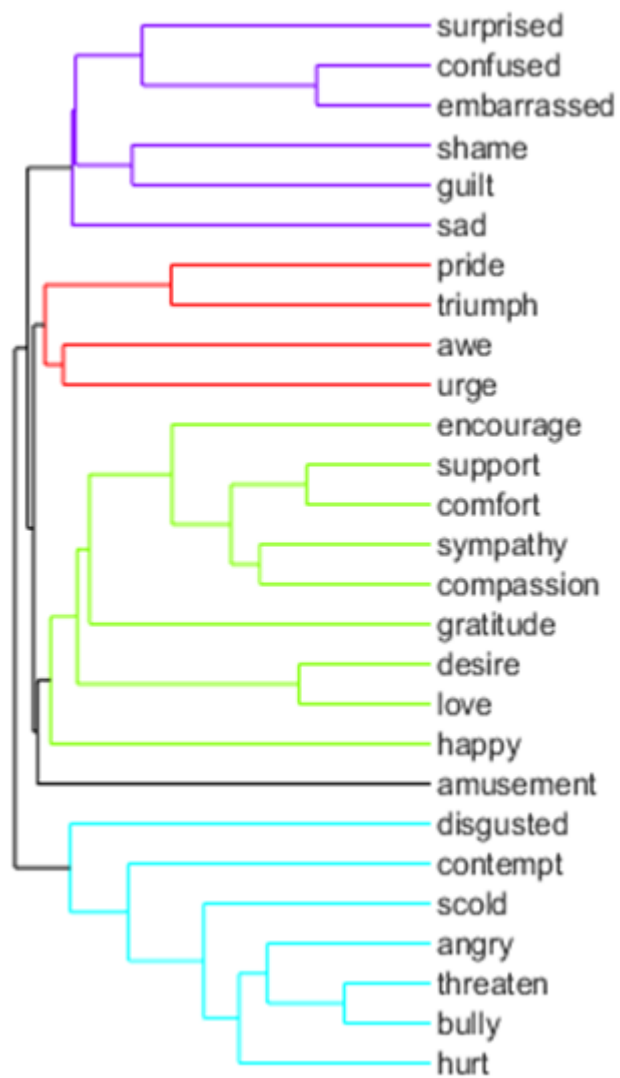


Figure S6 | Hierarchical clusters of the DA words according to the clustering of Figure 3

The dendrogram was generated using the clustergram function of MATLAB R2017b with correlation distance and clustering along the rows of data only.

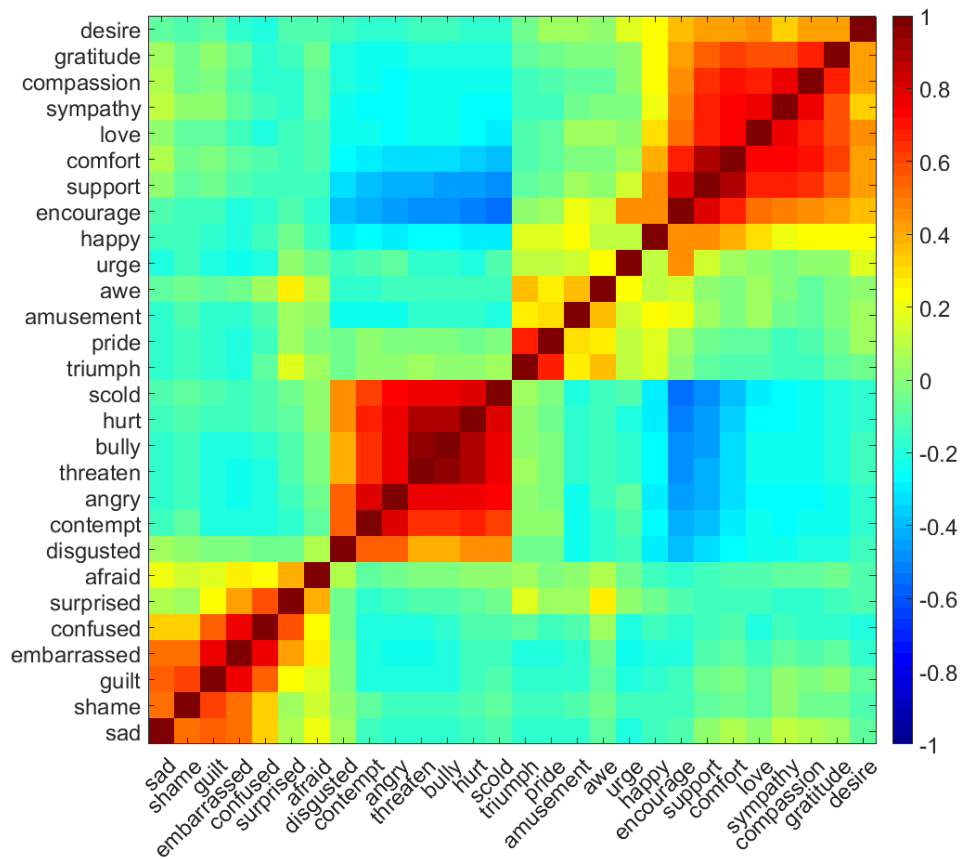


Figure S7 | Correlations between word scores cluster into several main groups

Clustering of the correlation matrix of all 28 words (DAs and emotions) shows a separation into several groups (large hot-colored square regions around the diagonal). The groups can be identified as positive (desire-happy), active negative (scold-disgusted) and passive negative (afraid-sad). A smaller group includes triumph-awe. There is a negative correlation (blue off-diagonal regions) between positive and negative valence groups.

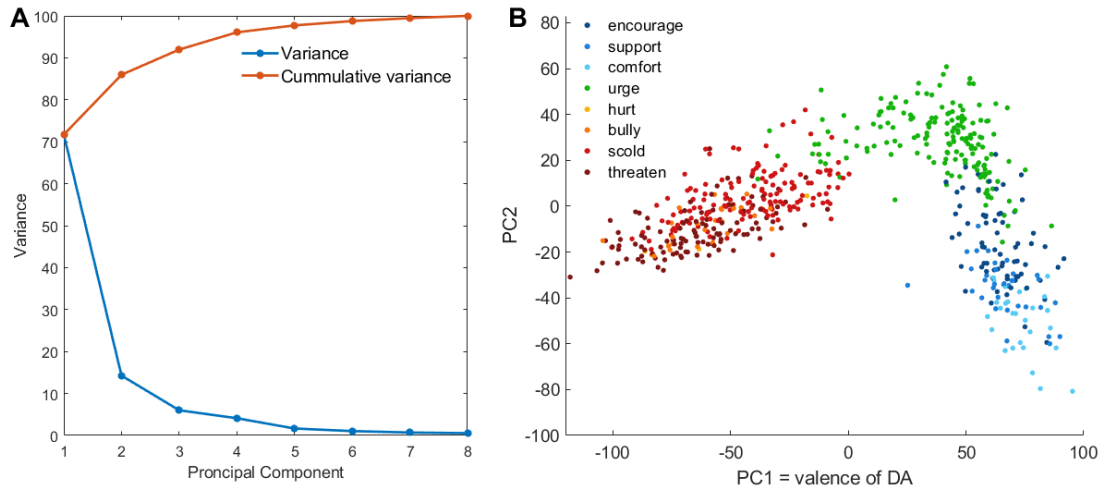


Figure S8 | Principal component analysis (PCA) of images identified with DA

(A) Scree plot for a PCA of the images using the median scores for DAs shows that the first 2 principal components explain 86% of the variance. We performed the PCA using the vector of 8 DA scores. (B) Images (dots) plotted in the plane of the first 2 principal components (PCs). Colors indicate the highest scored DA word for each image. Based on the DA words, we interpret PC1 as valence. Note the V-shape, which is similar to the shape of PCA applied on 22 DA words scores in (16), and to PCA analysis of emotions (58) .

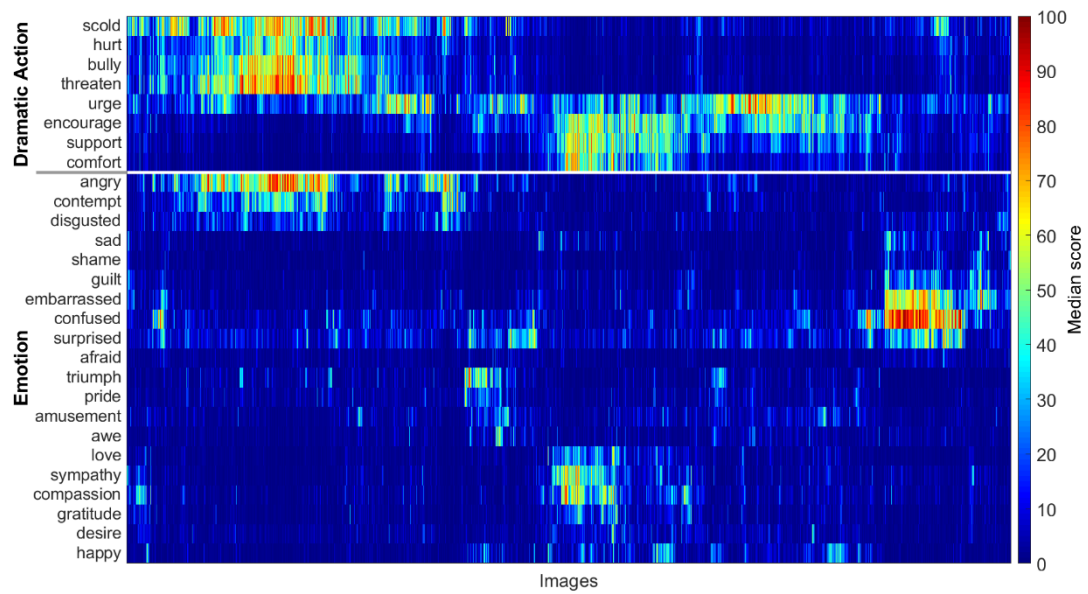


Figure S9 | Clustergram of all 1470 images according to raw median scores

Each column represents an image, and each row represents a DA or emotion word, arranged by clustering. Hence, images with similar scores are placed adjacently, and DAs or emotion words found in similar images are placed adjacently. Color represents median score, without zeroing out scores smaller than 50.

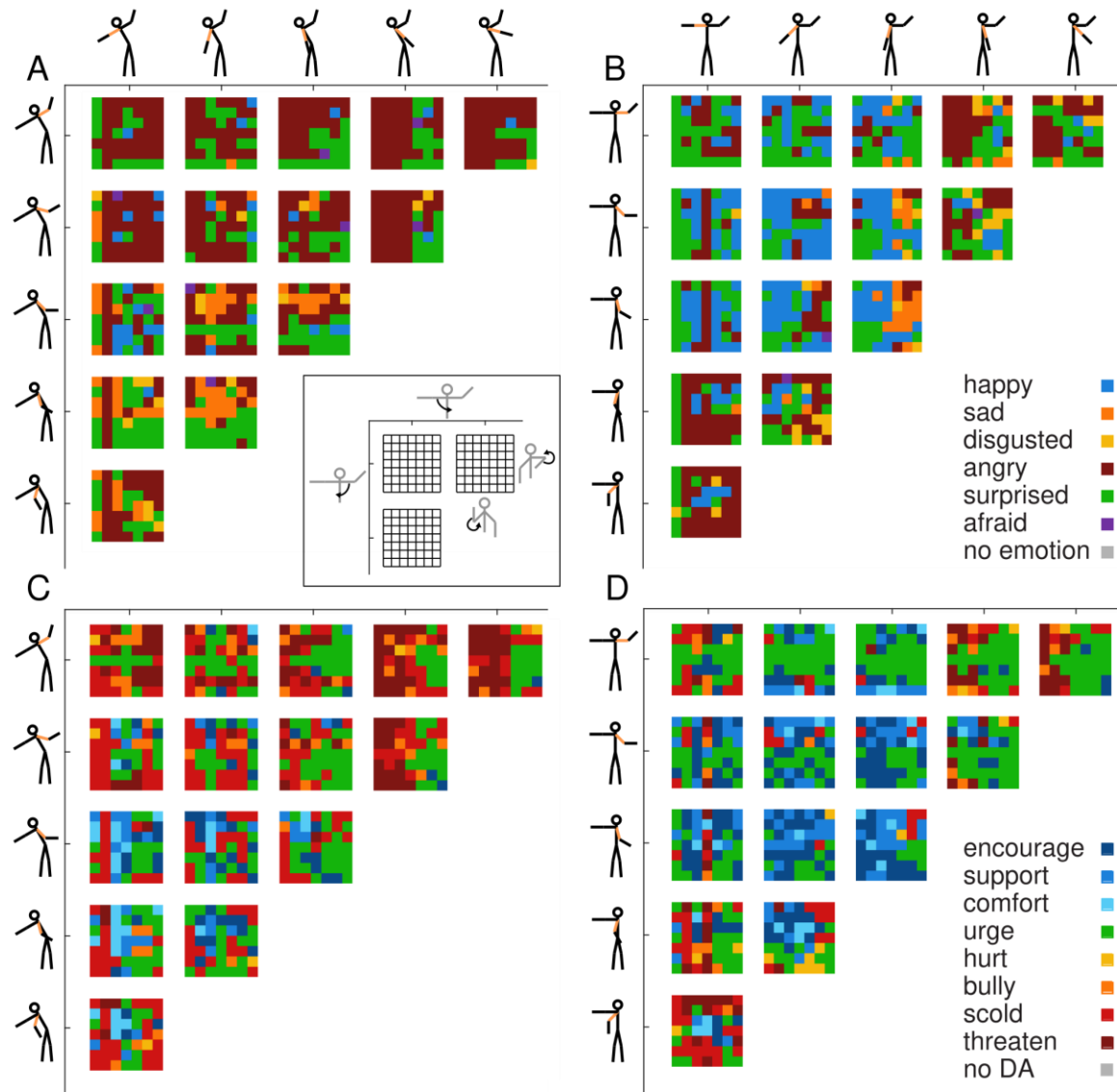


Figure S10 | A version of Figure 4 which displays the strongest DAs or emotions including those with scores lower than 50

All 1470 SF configurations are displayed in a set of panels, arranged as follows. A and B indicate tilted and upright torso, respectively. The 5x5 combinations of right and left shoulder angles correspond to 25 matrices, of which 15 are shown due to symmetry. Each matrix corresponds to the 7x7 elbow angles (axes in inset). SF configurations are color coded according to the emotion adjective with the highest score for each image. (C,D) same as above except that configurations are color coded according to the DA with the highest score for each image. Unlike Figure 4 which only shows DAs or emotions with scores above 50, this figure shows the strongest DA or emotion regardless of the score.

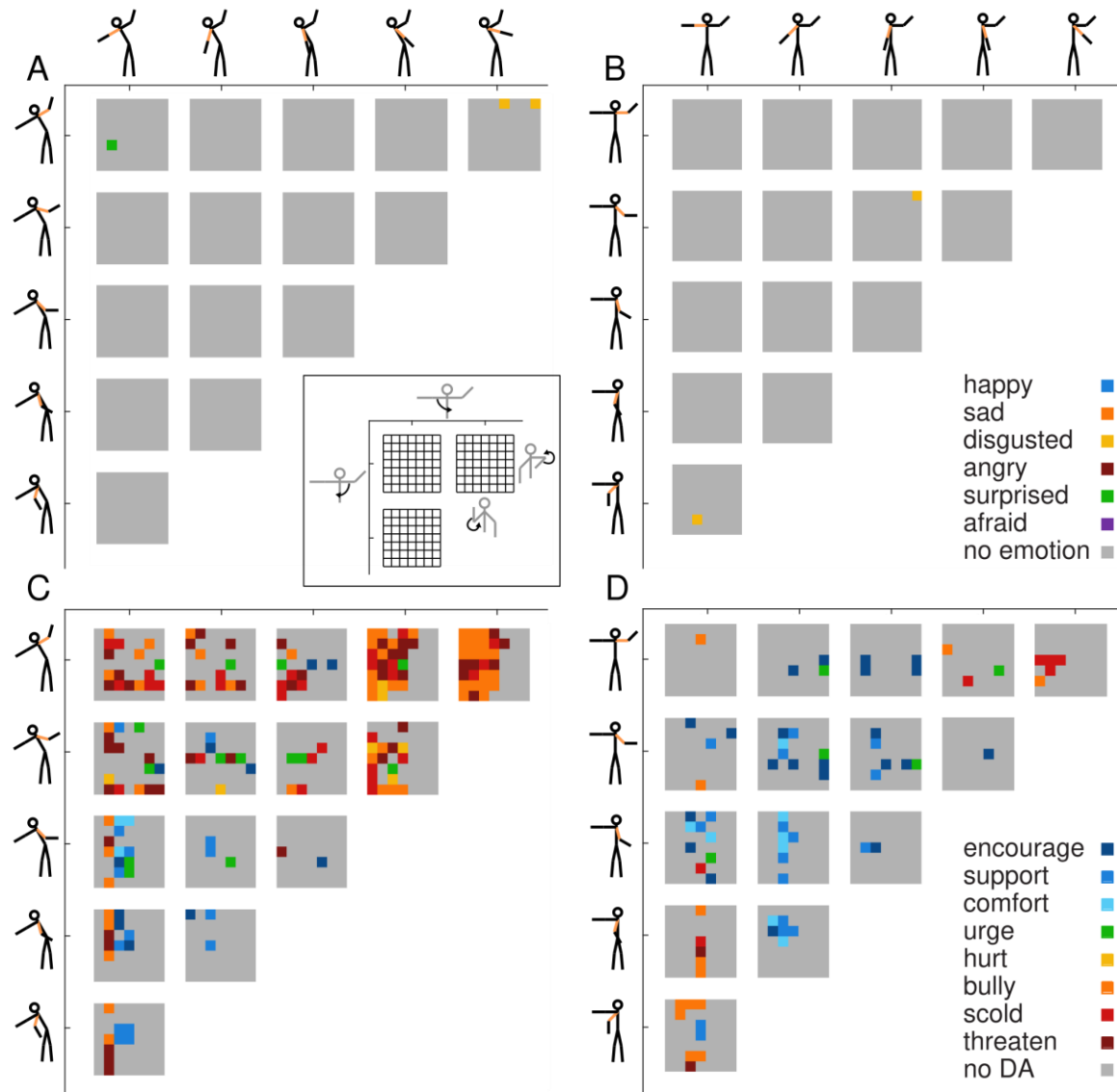


Figure S11 | A version of Figure 4 which displays the second strongest DAs or emotions with scores above 50

All 1470 SF configurations are displayed in a set of panels, using the same arrangement used in Figures 4 and S10. (A,B) SF configurations are color coded according to the emotion adjective with the second highest score for each image. (C,D) Same as above except that configurations are color coded according to the DA with the second highest score for each image.






	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Image		Angles					Dramatic action median scores										Emotion - Right m
2	#	Drawing	θ_1	θ_2	θ_3	θ_4	θ_5	bully	comfort	encourage	hurt	scold	support	threaten	urge	afraid-R	angry-R	disgusted-R
3	1		0	270	315	225	315	2	3	3	4.5	13	5.5	2	5	3	8	8
4	2		0	270	315	225	270	10.5	4	3.5	8.5	45	4	6.5	24.5	1	23	11
5	3		0	270	315	225	225	2	5	8	11	16	4	1	4	1	1	1
6	4		0	270	315	225	180	11	0	0	34	16	1	2	0	4	2.5	9
7	5		0	270	315	225	135	4	1	2	7	6	5	2	12	1	6	26.5

Figure S12 | Snapshot of the SF dictionary

The SF dictionary, available in excel format in ¹, contains 5 sections: image, angles, dramatic actions, emotions - right and emotions - left. The image section contains image thumbnails and the ordinal number of the image. The angles section details the five angles of the right SF. The median score for each DA, emotion of right SF and emotion of left SF is provided. An additional dictionary with the raw data of each word from all participants in the analysis is also available online.

¹<https://doi.org/10.6084/m9.figshare.13715365>

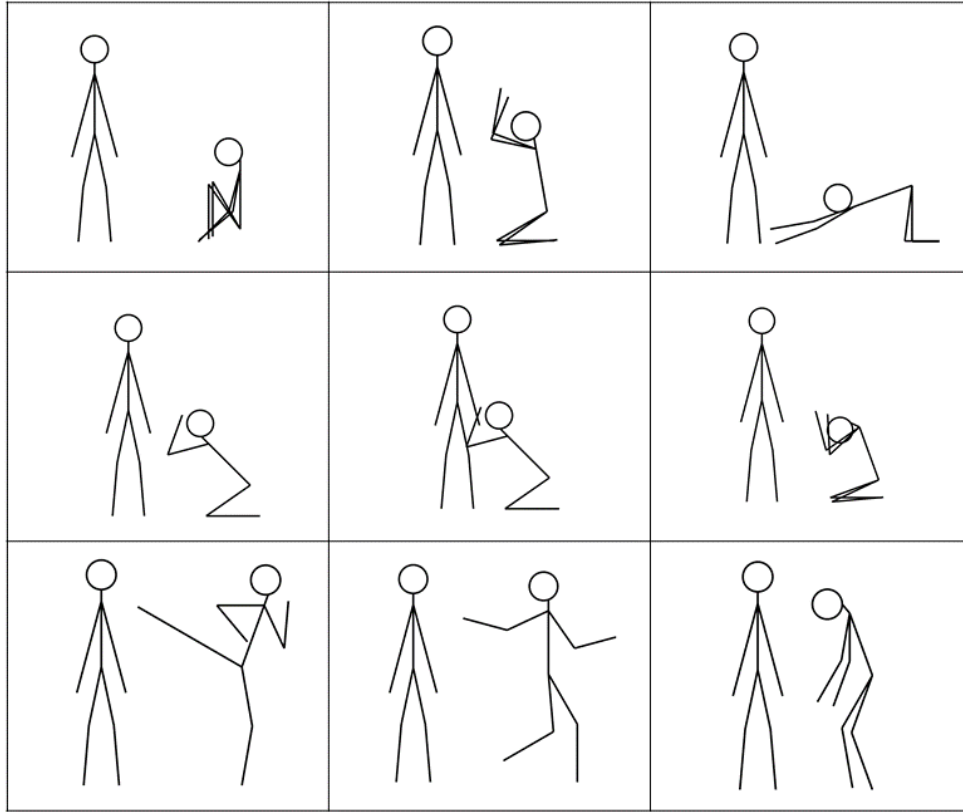


Figure S13 | Examples of additional stick figures configurations for further studies

Examples of stick figures with lower body configuration changes which seem to carry strong meanings, such as “to beg” and “to worship” in preliminary studies. This can point the way to future research with a richer set of body configurations.

Table T1 | Regression for predicting DAs given the scores for all emotions

DA word	R²	P value
Comfort	0.684	$< 10^{-300}$
Support	0.631	$< 10^{-300}$
Threaten	0.614	$< 10^{-200}$
Hurt	0.600	$< 10^{-200}$
Bully	0.591	$< 10^{-200}$
Scold	0.547	$< 10^{-200}$
Encourage	0.503	$< 10^{-200}$
Urge	0.154	$< 10^{-40}$

Table T2 | Regression for predicting emotions given the scores for all DAs

DA word	R²	P value
Angry	0.650	$< 10^{-300}$
Love	0.536	$< 10^{-200}$
Sympathy	0.536	$< 10^{-200}$
Compassion	0.502	$< 10^{-200}$
Contempt	0.471	$< 10^{-150}$
Gratitude	0.369	$< 10^{-100}$
Disgusted	0.265	$< 10^{-90}$
Happy	0.229	$< 10^{-70}$
Embarrassed	0.211	$< 10^{-70}$
Desire	0.204	$< 10^{-60}$
Confused	0.149	$< 10^{-40}$
Guilt	0.145	$< 10^{-40}$
Sad	0.117	$< 10^{-30}$
Shame	0.084	$< 10^{-20}$
Amusement	0.081	$< 10^{-20}$
Awe	0.076	$< 10^{-20}$
Surprised	0.062	$< 10^{-18}$
Triumph	0.043	$< 10^{-12}$
Afraid	0.039	$< 10^{-11}$
Pride	0.027	$< 10^{-7}$