The Art of Positivity in Drawing: Unveiling the Impact of Positive Mood States on Visual Creativity via Deep Learning

Sam Cong[1], Akram Bakkour[1, 2, 3]

[1]Department of Psychology, [2]Institute for Mind and Biology, [3]Neuroscience Institute, The University of Chicago

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Background

Modern cognitive theories view creativity as thought processes involving generating novel ideas, recombining existing information, and redefining problems from new perspectives[1].

The **Dual Pathway to Creativity Model**[2] follows this process-based view of creativity and further links creativity to mood via two cognitive routes:

- *Flexibility* (broad, associative thinking)—strengthened by positive activating moods
- *Persistence* (focused, effortful thinking)—enhanced by negative activating moods

While the Dual Pathway to Creativity Model has been extensively applied to verbal tasks in studying mood-creativity linkages, such tasks often overlook the dynamic and non-verbal aspects of creative thinking. To address this, we use a **novel integration of the Incomplete Shape Drawing Task and AI-driven analysis** to capture:

- *Flexibility*—via stroke dynamics (CoSE model) and narrative semantics (DSI)
- *Originality*—via deep learning predictions of human-rated creativity (AuDrA)

Our goal is to test whether positive activating moods enhance originality via increased cognitive flexibility, enabling switching between thoughts and integration of diverse ideas (i.e., the flexibility pathway to creativity).

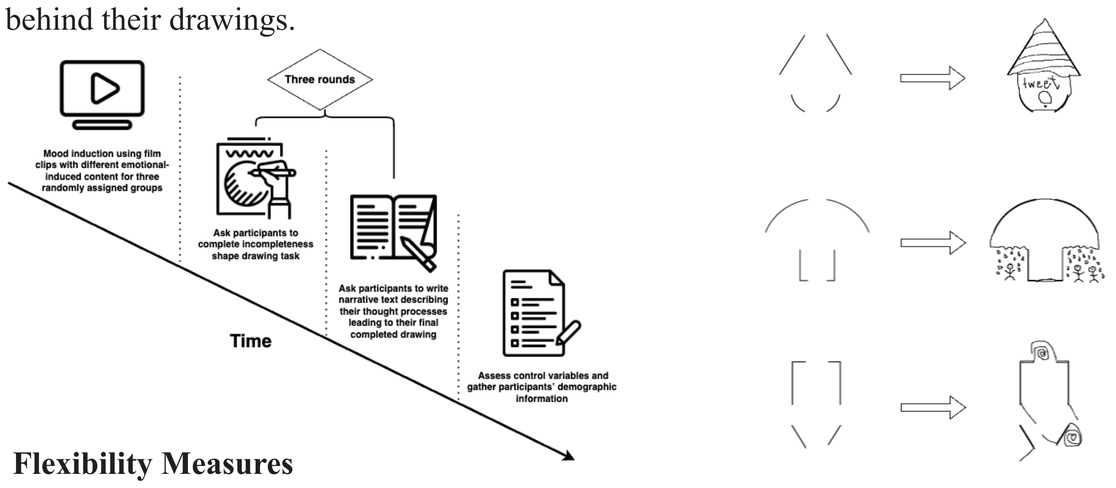
Methods

Participants

- N = 90 participants (based in U.S.) recruited from Amazon Mechanical Turk.

Experimental Design

- Participants were randomly assigned to one of three mood conditions using three validated film clips[3]: *High-Arousal Positive Mood*, *Low-Arousal Positive Mood*, and *Neutral Control* conditions.
- Participants then completed three rounds of the Incomplete Shape Drawing Task, where they turned abstract shapes into creative drawings and described their thought processes behind their drawings.



Flexibility Measures

- Leveraged Compositional Stroke Embedding (CoSE) model[4]—a generative model trained on human sketches—to derive stroke-by-stroke time series of 1) **entropy** (uncertainty in predicted stroke trajectories) and 2) **Bhattacharyya distance** (divergence between alternative stroke predictions). These were summarized as *averages* (exploratory breadth) and *inflection proprotions* (switching dynamics).
- Applied **Divergent Semantic Integration (DSI)**[5], a BERT-based measure of conceptual distance between narrative elements, to capture flexibility.

Originality Measure

- Originality was automatically rated using **AuDrA**[6], a deep learning model trained on human creativity ratings of the same drawing task.

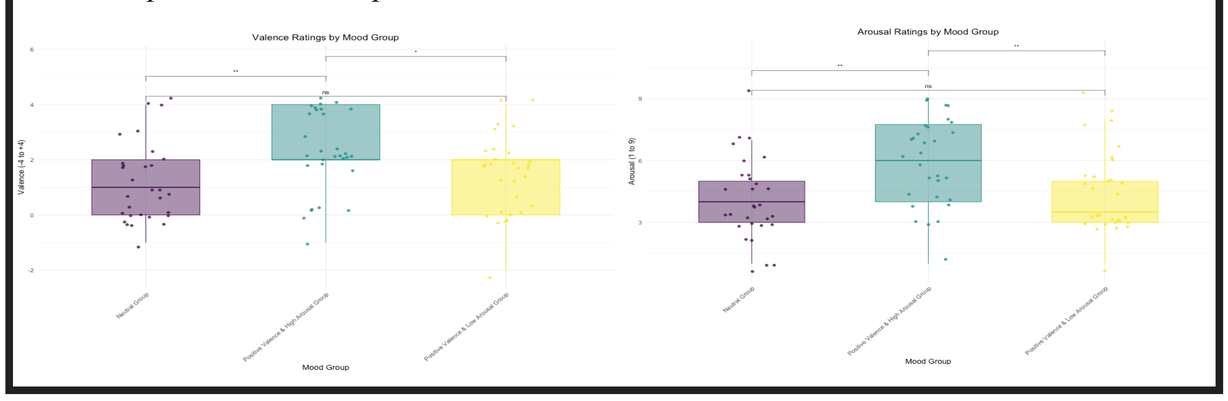
Statistical Analysis

- Conducted **mediation analysis** to test whether the effect of positive activating mood on originality is mediated by flexibility while controlling for state affect, openness, trait flexibility, and self-rated artistic skill.

Results

Manipulation Check: Mood Induction

- The experimental mood induction procedure using three validated film clips achieved the anticipated mood manipulation results.



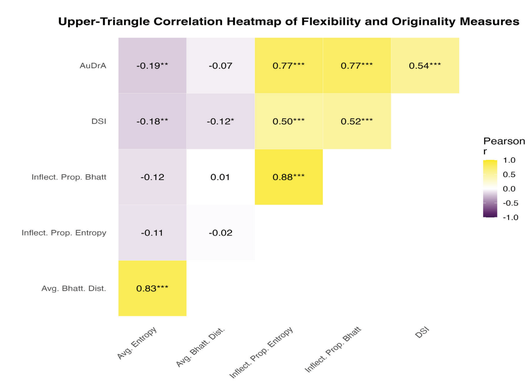
Results

Group Comparison of Flexbility and Originality Measures

- **Mood induction did not affect the originality aspect of creativity or any of the process measures**.
- Given the absence of group-level effects on flexibility or originality, **mediation analysis was not performed**.

Measure	$F(2, 87)$	p	η^2
Avg. Entropy	1.30	.2784	.029
Avg. Bhatt. Dist.	0.44	.6456	.010
Inflect. Prop. Entropy	0.41	.6620	.009
Inflect. Prop. Bhatt	0.12	.8850	.003
DSI	0.63	.5375	.014
AuDrA	0.18	.8357	.004

Note. Avg. Entropy = Average Entropy; Avg. Bhatt. Dist. = Average Bhattacharyya Distance; Inflect. Prop. Entropy = Inflection Proportion of Entropy; Inflect. Prop. Bhatt = Inflection Proportion of Bhattacharyya Distance; DSI = Divergent Semantic Integration; AuDrA = Automated Drawing Assessment (Originality Score).



Correlational Analyses of Flexibility and Originality Measures

- Average entropy and average Bhattacharyya distance were strongly positively correlated with each other (r = .83), but both showed significant but weak correlations with their respective inflection metrics and with DSI (rs between –.12 and –.18).
- The two inflection-based measures were strongly positively correlated with each other (r = .88), and both were moderately positively associated with DSI (r > .50).
- Two distinct behavioral strategies: one characterized by **persistent exploratory breadth** (high average entropy and Bhattacharyya distance) and another characterized by **dynamic switching between ideas** (high inflection proportions and DSI).

Predictor	Estimate (β)	95% CI	p-value
(Intercept)	0.30	[0.16, 0.43]	< .001
Avg. Entropy	−0.07	[−0.17, 0.02]	.105
Avg. Bhatt. Dist.	0.00	[−0.02, 0.03]	.772
Inflect. Prop. Entropy	0.18	[0.11, 0.25]	< .001
Inflect. Prop. Bhatt	0.16	[0.09, 0.23]	< .001
DSI	0.06	[0.02, 0.09]	.004
Positive Affectivity	−0.00	[−0.00, −0.00]	< .001
Negative Affectivity	0.00	[−0.00, 0.00]	.083
Openness to Experiences	0.00	[−0.00, 0.01]	.129
Cognitive Flexibility	0.00	[−0.00, 0.00]	.104
Self-Rated Artistic Skill	−0.00	[−0.01, 0.01]	.531
Random Effects			
Residual Variance (σ^2)	0.00		
Intercept Variance (Participant) (τ_{00})	0.00		
ICC	0.07		
N (Participants)	90		
Observations	270		
Marginal R^2 / Conditional R^2	0.725 / 0.745		

Note. CI = confidence interval; ICC = intraclass correlation coefficient. Estimates reflect fixed effects from a multilevel model with random intercepts for participants. Avg. Entropy = Average Entropy; Avg. Bhatt. Dist. = Average Bhattacharyya Distance; Inflect. Prop. Entropy = Inflection Proportion of Entropy; Inflect. Prop. Bhatt = Inflection Proportion of Bhattacharyya Distance; DSI = Divergent Semantic Integration; AuDrA = Automated Drawing Assessment (Originality Score).

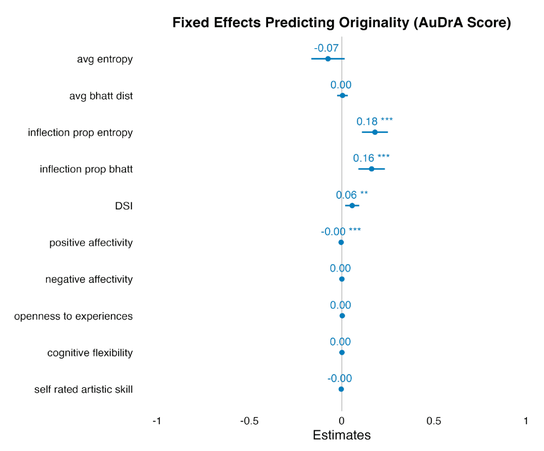


Figure 7: Fixed effects estimates from the multilevel regression model. Error bars indicate 95% confidence intervals. avg entropy = Average Entropy; avg bhatt dist = Average Bhattacharyya Distance; inflection prop entropy = Inflection Proportion of Entropy; inflection prop bhatt = Inflection Proportion of Bhattacharyya Distance; DSI = Divergent Semantic Integration.

Multilevel Regression Analysis: Predicting Originality From Flexibility Measures

- Correlation analyses above highlight the importance of examining process-level predictors of the originality aspect of creativity, independent of mood effects.
- The inflection-based measures and DSI, which were positively correlated and previously shown to relate more closely to originality, emerged as significant predictors of orignality here as well.

Take-Home Messages

- While our mood induction procedure successfully altered both arousal and valence, its **downstream impact on creative performance was unexpectedly limited**.
- Adaptive flexibility—not persistent exploratory breadth—was reliably associated with higher originality.
- Although the present study did not replicate the hypothesized effect of positive activating mood on creativity, the findings nevertheless lend support to the **association between process-level flexibility and originality**.
- From a methodological standpoint, the convergence of flexibility-originality pathway across the two modalities (i.e., drawing and narrative) provides empirical support for their **validity of the measures employed**.
- Drawing, when paired with principled computational methods, is a powerful and underutilized modality for assessing creative processes across cognitive and representational domains.

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