Creativeable: Leveraging AI for personalized creativity enhancement

Ariel Kreisberg-Nitzav [1], Yoed N. Kenett [2,*]

Supplementary Information

Text S1: The prompt that was used to generate SWT word triplets.

Generate a set of 32 distinct word triplets (32 sets of three words each). Each triplet should consist of words representing objects or concepts. The triplets should be structured such that:
1. The first few triplets (e.g., the first 5-10) contain words that are semantically close (e.g., synonyms, closely related concepts, or items within the same category).
2. As the list progresses, the semantic distance between the three words in each triplet should gradually increase.
3. By the final few triplets, the words should be highly semantically distant, with little or no obvious relationship between them.

Ensure diversity in the selection of words, incorporating various domains such as nature, technology, emotions, abstract concepts, and everyday objects. Avoid proper nouns and overly obscure terms. The progression in semantic distance should be gradual and evident.

Output Format:
Provide the triplets as a numbered list, formatted as follows:
1. ***[word1, word2, word3]***
2. ***[word1, word2, word3]***
…
3. ***[word1, word2, word3]***

Text S2: Prompt used for feedback and task difficulty level adjustment.

You are tasked with evaluating a very short story I wrote (3-4 sentences), which incorporates three specific words I was asked to incorporate into that story in a seamless and creative manner. Provide your assessment in a JSON format. Your evaluation includes:

1. Providing concise feedback (limited to 2 sentences) on my story, JSON key: "feedback".
2. Suggesting one general primary way for me to improve my creativity or brainstorming process for such task, and not necessarily for that specific story. Try to avoid repeating the same suggestions throughout the chat. JSON key: "suggestion".
3. Considering how I executed the short story task, along with my current level of fatigue, you are asked to determine if the complexity of the task should be adjusted to provide a suitable challenge. Should you find that my performance was strong and demonstrated a high level of creativity, the task's difficulty can be increased. Conversely, if my performance suggests otherwise or I'm very fatigued, the difficulty should be decreased. Please respond with either 'raise' or 'lower' for the JSON key 'difficulty adjustment'.

My fatigue level: {fatigue_dict[player.self_fatigue]}

The story's writing prompt consisted of three words: {player.word1}, {player.word2}, {player.word3}

The story I wrote was:
{player.story}

Text S3: Prompt used to rate the creativity scores of the stories.

You are a creative writing expert. In an online survey, participants received three words representing different concepts and were asked to write a brief, imaginative story using these words. You'll review a participant's story alongside the word trio provided as their writing prompt.
Your job is to rate the story's creativity on a scale of 1 to 10 (1 being least creative, 10 being highly creative). Assess how imaginative, surprising and original its characters and plots are. Consider how effectively the three given words were woven into the narrative—whether their integration was creative or not. You should return your response in a json of the following format:
{{"score": a numeric score between 1-10, rating the creativity of the story,
"explanation": "a very brief explanation of up to 2 sentences for why you chose to rate the story the way you did"}}.
The word triplet is: {triplet}, the short story is: {story}

Text S4: The reflection questions participants were asked regarding their stories after writing them at each round:

- Self-reported creativity: "Reflecting on the story you've just written using the three words provided as prompts, how would you rate the level of creativity in your story?" (1 – "Not Creative," 5 – "Highly Creative").
- Perceived task challenge: "How challenging did you find it to compose a short story based on the three given words?" (1 – "Very Easy," 5 – "Very Challenging").
- Self-reported fatigue: "How much fatigue are you experiencing at this point in the study?" (1 – "No Fatigue: I feel completely energized and alert," 5 – "Extreme Fatigue: I am extremely tired to the point where it's very difficult to continue").

Table S1: Word triplets used in the story writing task (SWT) with semantic distance and difficulty ratings from human raters.

Note: Semantic distance is calculated as $\mathbf{1} - \boldsymbol{cosine\ similarity}$ between each pair of words within a triplet, then averaged to obtain the intra-triplet semantic distance.

	Avg. Semantic Distance (0-2)	*Avg. difficulty scores (1-10)*
Easy level	*M = 0.675, SD = 0.145*	*M = 3.42, SD = 0.977*
"cafe", "coffee", "conversation"	0.743	2.0
"forest", "tree", "wildlife"	0.467	2.0
"detective", "mystery", "clue"	0.757	3.667
"library", "book", "knowledge"	0.625	3.0
"ocean", "wave", "seashell"	0.657	4.0
"dessert", "atom", "flamenco"	0.889	4.0
"mountain", "hiking", "summit"	0.488	4.375
"bicycle", "map", "picnic"	0.773	4.333
Medium-easy level	*M = 0.774, SD = 0.147*	*M = 5.423, SD = 0.305*
"telescope", "journal", "comet"	0.680	5.0
"gallery", "orchard", "whisper"	0.968	5.0
"candle", "notebook", "melody"	0.750	5.333
"typewriter", "harbor", "seagull"	0.879	5.4
"bakery", "dough", "aroma"	0.702	5.8
"bowling", "butterfly", "astronomy"	0.811	5.5
"garden", "flower", "sunlight"	0.505	5.6
"crocodile", "skyscraper", "dance"	0.901	5.75
Medium-hard level	*M = 0.902, SD = 0.048*	*M = 6.212, SD = 0.352*
"submarine", "ice cream", "philosophy"	0.900	6.8
"piano", "trail", "feather"	0.862	5.8
"rainforest", "cinema", "mathematics"	0.843	6.0
"rhinoceros", "telescope", "jazz"	0.936	6.0
"skyscraper", "zebra", "harmonica"	0.983	6.0
"wolf", "earrings", "meteorology"	0.937	6.143
"dinosaur", "laptop", "baking"	0.905	6.286
"dandelion", "telescope", "romance"	0.855	6.667
Hard level	*M = 0.907, SD = 0.059*	*M = 7.333, SD = 0.281*
"strawberry", "equation", "sculpture"	0.809	7.0
"computer virus", "pomegranate", "ballet"	0.925	7.0

"seashell", "moonwalk", "mathematics"	0.911	7.0
"chef", "canvas", "laughter"	1.004	7.5
"microscope", "waterfall", "poetry"	0.859	7.5
"penguin", "pyramid", "microprocessor"	0.898	7.5
"sandwich", "tractor", "olympics"	0.958	7.5
"volcano", "hairbrush", "stock market"	0.898	7.667

Table S2: Examples of creativity improvement suggestions generated by Creativeable in the feedback conditions.

Examples of creativity improvement suggestions	
Divergent Thinking Techniques Encouraged participants to explore a broad range of ideas, often through methods like mind mapping, which involves diagramming ideas to uncover unexpected connections, and free writing, where participants write continuously without concern for grammar or structure. These techniques aimed to facilitate a free flow of ideas, which could be beneficial for integrating diverse elements into a cohesive story and enhancing associative thinking.	*To improve your brainstorming process, try utilizing mind mapping to visually organize your thoughts and see how different concepts or elements could connect within your story.*
	Employ the 'What if?' technique to methodically explore the unlimited possibilities stemming from each word, which can lead to more coherent storytelling.
Writing Techniques Encouraged participants to enhance their storytelling by incorporating various literary devices and thematic elements. Techniques such as foreshadowing, metaphorical language and genre exploration were suggested to deepen narrative complexity and creative expression. Participants were also encouraged to experiment with different sentence structures, use settings to reinforce story elements, and introduce conflict or unexpected twists to add depth and engagement.	*Incorporate elements of foreshadowing or thematic linking. For example, you could hint at the next performance subtly in the description of the current act or tie the performances together with a common thread that aligns with the story's setting or characters.*
	To boost creativity, experiment with different literary devices, such as metaphor or alliteration, which can add depth or a playful twist to your storytelling.

Perspective Shifts Focused on encouraging participants to write from unconventional viewpoints, such as non-human entities, or using unreliable narrators. For example, a suggestion might prompt a participant to write from the perspective of a rhinoceros or a telescope, challenging them to break away from typical storytelling modes and uncover unique story angles.	*Experiment with writing from different perspectives to enhance creativity. For example, imagine the story from the rhinoceros's point of view or the telescope observing you, which could lead to surprising and inventive angles.*
	Experiment with different perspectives or narrative structures such as a non-linear timeline or an unreliable narrator to add depth and fresh angles to your stories.
Rest and Rejuvenation Highlighted the importance of taking breaks to maintain creativity and mental clarity. Techniques like the Pomodoro Technique, which involves working in intervals with short breaks, were suggested to prevent cognitive overload. Additionally, passive brainstorming activities, like listening to music or taking walks, were recommended to refresh the mind. However, such suggestions were less practical within the study setting, as participants were compensated for their time and needed to complete the study within a reasonable timeframe.	*For stimulating your creative process, set aside time for freewriting sessions where you write continuously without editing for a set period. This can help generate raw material and unexpected connections between ideas.*
	Given the moderate fatigue you're experiencing, try a technique like the Pomodoro Technique to break your work into short sprints with breaks in between. This can help maintain your concentration and creativity despite tiredness.

Creative Constraints and Challenges Involved using limitations, such as word counts or specific genres, to stimulate creative thinking. For instance, participants might be tasked with writing a story with only three characters or within a specific genre, like mystery or science fiction. These constraints encouraged focused and inventive storytelling by requiring participants to find unique solutions within defined limits, an essential aspect of creative problem-solving.	*Try utilizing constraints, such as limiting the number of characters or setting a specific time period to your story, to foster creativity within a more focused scope.*
	Explore different genres or tones to expand your creative boundaries; if this story is whimsical, perhaps attempt a mystery, a horror short, or a piece with a more serious tone next time.
Sensory and Emotional Immersion Emphasized engaging the reader's senses and emotions to create a more immersive narrative. Participants were encouraged to incorporate vivid sensory details, like the smell of freshly baked bread or the sound of rain, to enhance the atmosphere of their stories.	*Explore sensory details in your writing by focusing on sight, smell, touch, taste, and sound. This technique can add richness to your stories and may lead to discovering unexpected connections between your prescribed words.*
	Enhance your creativity by engaging with various artistic mediums that might inspire you, such as paintings or music, to evoke emotions and ideas that could be woven into your writing.

Table S1. Examples of improvement suggestions given by the trainer to various participants in the feedback conditions (F/VL and F/CL).