Early Results with Faceted Classification of "Alternate Uses" Test Responses

Kyle E. Jennings
Institute of Personality and Social Research, University of California, Berkeley
jennings@berkeley.edu

ABSTRACT
Generating ideas is central to creativity. To improve understanding of the idea generation process, measurements are needed that go beyond the typical indices of fluency, originality, elaboration, and flexibility. Faceted classification, which puts each idea into several conceptually orthogonal hierarchies, is suggested as an alternative. A distance metric over faceted classifications is defined. When applied to adjacent ideas on alternate uses tests, it correlates highly with time between responses. This demonstrates faceted classification's promise as a high-resolution (though also time intensive) way to characterize ideation.

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INTRODUCTION
Generating many ideas is at the core of the creative process. The "alternate uses" test, which asks participants to list alternate uses for a common object, is one of the most common laboratory tasks in creativity research. However, typical scoring techniques are rather blunt instruments; rich and varied data are reduced to the number of responses per person, how uncommon those responses are, how long these responses are, and how many "kinds" of responses are represented. Though these are good aggregate measures of a person's output, they cannot answer more detailed questions about the idea generation process, such as whether big conceptual leaps were taken, whether brainstorming partners took inspiration from each other, or whether mental blocks were defeated. These answers hide in plain sight among each person's idea list, but they cannot be discovered just by counting.

The closest that traditional scoring systems come to a more in-depth characterization of ideation is the flexibility score, which depends on grouping responses that share similar features. However, ideas share many kinds of features with each other, and so a decision must be made about which features are most important. Inevitably, some connections and some dissimilarities will be obscured. What's more, a single level of classification might obscure higher-level commonalities, and hence jumps between similar classes will be indistinguishable from jumps between very different classes. To solve these problems, idea attributes are organized into multiple, conceptually orthogonal hierarchies, which are called *facets* [5]. This approach allows a nuanced view of how ideas relate to each other, creating several interesting possibilities:

- Originality can be examined across all facets. This way, "use a shoe to swat a praying mantis" is correctly seen as only superficially original given its similarity to the more common "use a shoe to swat a fly", rather than as an unique response.
- Group brainstorming protocols can be coded to look for evidence that people combine elements of other people's ideas to form hybrids.
- People's idea search strategies can be characterized by how they switch between dimensions of a solution, combine elements of past solutions, and alternate between incremental and major changes to their idea (cf. [2]).

In order to demonstrate the usefulness of faceted classification, it must be shown that the system can meaningfully describe how people generate new ideas. Assuming that creative ideation proceeds via a search of associations in memory [4], and assuming that an idea primes the concepts behind it, as well as related concepts [1], then it should be easier to produce an idea that shares many features with or uses features of a similar type as a recently-thought of idea. Therefore, the time between when two ideas are produced should be inversely related to how many concepts they share in common, and how similar the new concepts are to old ones. Equivalently, one can hypothesize that the conceptual distance between two ideas produced in succession, as measured by comparing faceted classifications of these ideas, should be positively correlated with the amount of time between when the two ideas were produced.

EXPERIMENT
Methods
There were $N = 27$ participants, who were all students at the University of California, Berkeley. The entire experiment was done on a computer. The instructions asked participants to list as many alternative uses for a brick as they were able to within three minutes, and to separate responses by pressing enter. This enabled the measurement of time between responses.

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Responses with the exact same meaning were grouped. In order to compare traditional flexibility coding with faceted classification, these were put into 12 high-level classes, or responses sharing one or more dominant features, but differing on other features. The kinds of features defining each class varied widely. For instance, one class includes uses taking advantage of a brick's roughness, while another includes all weapon-related uses. For proof of concept, only two top-level facets were coded. The first, "property", describes what physical or conceptual feature of the brick is exploited. The second, "state", describes the static configuration or dynamic motion of the brick. There were about 70 levels of hierarchy between the two facets.

Results and Analysis

Distance between adjacent uses is based on Tversky's [6] similarity metric, rewritten as a distance, $D(A, B)$:

$$D(A, B) = \frac{2 \cdot f(A \setminus B) + 2 \cdot f(B \setminus A)}{f(A \cap B) + 2 \cdot f(A \setminus B) + 2 \cdot f(B \setminus A)}$$

Here, A and B are two concepts, thought of as sets of properties. Note that unshared features increase distance more than shared features decrease it. In order to deal with hierarchical relationships between features, each facet is expanded to include the concept at each level of its conceptual tree. Thus, `a/b/c` expands into `a`, `a/b`, and `a/b/c`. This recognizes that it is easier to transition from `a/b/c` to `a/b/d` than to `a/e/f`. Because certain responses are more common (and so presumably easier to activate), $f(\{F_i\}) = \Sigma g(F_i)$, where $g(F_i)$ is one minus the probability of the facet F_i, conditioned on its immediate parent. For instance, if $F_i = \mathtt{a/b/c}$, then $g(F_i) = 1 - P(\mathtt{a/b/c} \mid \mathtt{a/b})$. Conditional probabilities are estimated from the response sample.

To test the hypothesis, the correlation between conceptual distance and time between responses was computed. (Since response times have a skewed distribution, the standard practice of taking the $\log$ of time was followed.) The hypothesis was well supported. The correlation between time and conceptual distance was $r = .27$, $p < .0002$ ($df = 189$). The mean per-participant correlation (using Fisher's Z) was .19, which is different from zero, $t(26) = 2.47, p < .05$. For comparison, each response was coded for whether it represented a different response class than the prior response. Responses that changed class indeed took longer than those that did not, $t(47.79) = -2.70, p < .01$, which corresponds to a correlation of $r = .21$.

Discussion

The hypothesis that the conceptual distance between adjacent divergent thinking responses would be positively correlated with the time between responses was supported. Faceted classification performed as well or better than traditional flexibility coding. This is despite the fact that an incomplete faceted classification scheme was used. What's more, the classification was done *a priori*, and in particular without first looking for common response order patterns. Thus, this is a strong suggestion that faceted classification can be a useful way to understand divergent thinking responses.

GENERAL DISCUSSION

This research shows that faceted classification is a promising approach that should be pursued further. The approach is admittedly difficult to apply. However, many meaningful measurements are difficult but invaluable (e.g., facial action coding, physiological measurement, brain imaging). The benefit in this case should be a high resolution description of people's idea search trajectories.

Other studies are underway that use faceted classification. One study tests how telling people to "be creative" changes their idea generation strategies (e.g., do people generate long strings of essentially identical ideas, or do they make larger jumps between ideas?). Separately, a faceted classification scheme is under development for a more real-world problem in which undergraduates think of ways to improve the freshman roommate assignment process. This will be applied to experiments with brainstorming and other creativity enhancement techniques (e.g., [3]), and will enable better characterization of the idea search process.

Science depends on the careful observation of phenomena, and then the careful analysis of the resulting data. Therefore, scientific advances often come on the heels of new measurement instruments and data analysis techniques. Regardless of whether faceted classification can fulfill this role for creativity research, it is probably true that better measurement and analysis techniques are needed. If nothing else, this work should stimulate some thinking in that direction.

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