Combined Intuition and Rationality Increases Software Feature Novelty for Female Software Designers

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Different cognitive styles can promote novelty when designing software. Through a detailed experiment, we found that female practitioners who had a preference for more than one cognitive style (intuition and rationality) produced the most novel software features of all the participants.

SOFTWARE DESIGN PRACTITIONERS, like all people, have different cognitive styles. Cognitive style refers to the different ways in which people obtain, organize, and process information.¹ Intuition and rationality are two such cognitive styles. A practitioner designing a software feature through an intuitive style might do so quickly, and have a gut feeling that their solution is the right one. Conversely, a practitioner using a rational style would arrive at a particular feature more slowly, justifying their solution in the context of available requirements. Both styles can be used by a practitioner at any time, in a particular order, or even simultaneously. Still, all people tend to usually rely on one or both styles in a specific configuration,² known as their dispositional style.

There is consensus in the software engineering community that practitioners sometimes rely on their intuition when designing software. Despite this, the emphasis in the software development process has generally been on promoting a rational cognitive style through rationalized processes, tools, and techniques. Meanwhile, the potential benefits of an intuitive style have been largely ignored.³ One such benefit of intuition is novelty,⁴ crucial for tackling complex societal problems such as inequality, climate change, and poor health.

Why Feature Novelty?
When designing software for a complex problem, software design practitioners, like product designers and requirements engineers, create new features to (partially) solve the problem. These practitioners tend to start off by sketching various ideas for a design on a whiteboard or a piece of paper.⁵ They will then cycle back and forth between their understanding of the problem and their idea(s) for a
potential feature, updating these concurrently as they go along.

Nowadays, software solutions naturally lend themselves to addressing societal problems. However, the reality is that such problems demand substantial levels of novelty in software features.\(^6\)

**Cognitive Style and Gender Meet Feature Novelty**

Both intuition and rationality have been positively related to novelty. Intuition has been shown to result in more novel solutions through holistic information processing and promoting associative thinking;\(^4\) the “big picture.” Rationality enables practitioners to assess details, and to analytically compare potential solutions.\(^2\) Nevertheless, whether this is specifically true for software design practice remains to be seen.

Although dispositional style is not inherently gender specific, it has been demonstrated that the interaction between gender and job type can influence preference for intuition.\(^7\) Given that female practitioners are often underrepresented in software engineering,\(^8\) endure unique barriers to entering the field,\(^9\) and are subject to a number of different biases,\(^10\) we were particularly curious about whether the novelty of software features designed by software design practitioners would vary based on their gender and dispositional style. When speaking of male and female in our study, we take gender to be a self-identification construct, which may or may not align with biology or presentation.\(^11\)

Given these potential associations between cognitive style and feature novelty, and gender differences in style preference, our study investigated whether a certain combination(s) of cognitive style and gender led to higher software feature novelty.

**Study Design**

We conducted an experiment with practitioners to enable some control, while still maintaining real-world applicability. Practitioners, whose primary task involves the high-level design of features in any software engineering role, were recruited through the online platform Prolific. Such participants were familiar with the complexity of the task and comfortable with producing rough, wireframe-like sketches. First, participants took part in a feature design task. Afterward, the same participants were randomly assigned to evaluate the novelty of 10 features designed by others. We chose to focus on obesity as our context as it is a well-known issue with which participants would likely be familiar.

**Feature Design Task**

Participants were given an explanation of the problem and instructed to design at least one feature for a mobile application. They were then given 15 min to sketch their software feature(s) on a piece of paper and provide suitable explanations using a basic template.\(^5\) Figure 1 presents a selection of the designed features.

Later we asked the participants to note which of their features—if they designed more than one—best solved the problem. The participants then photographed or scanned their features and uploaded them.

To measure participants’ dispositional cognitive style, we used Rational-Experiential Inventory-10, which consists of five statements about participants’ use of intuition and five about their use of rationality,\(^2\) measured on a seven-point scale from “completely disagree” to “completely agree.” We dropped one item from the rationality scale that reduced the scale validity.

We collected participants’ self-identified gender in the same section in which we asked control questions about work-relevant experience, industry role, age, and familiarity with obesity. Participants were paid £4 for completing this part of the study.

**Feature Evaluation Task**

After completing the design task, participants were contacted again and randomly organized into groups of five participants. Each group evaluated the same 10 randomly selected features (always excluding their own). For each feature design sketch, participants were required to answer the following question: “How novel is this feature when compared with existing features from applications in the market?” Their answers were recorded on a five-point scale ranging from “not novel at all” to “extremely novel.” Participants were paid £2 for completing the evaluation of all 10 features. To measure feature novelty, we calculated an average novelty score for each participant based on the five evaluations of their best (or only) feature.

**The Sample**

One hundred ten practitioners had their top-rated feature evaluated. This was reduced to 80 following data cleaning. Of the total number of participants, 26.25% were female and 73.75% were male. Of the total number of participants, 23.8% had a high preference for intuition, but a low one for rationality; 23.8% had a high preference for rationality, but a low one for intuition; 22.5% had a high preference for both; and 31.2% had no preference for either cognitive style. Participants’ professional design
experience varied from less than one year to more than 20 years, with the average being 5.44 years.

Data Analysis
We used hierarchical moderated regression analysis to determine whether gender, intuitive style, or rational style could significantly account for differences in feature novelty in isolation and when taken together. For this purpose, the three variables were included individually and in all possible two- and three-way combinations in our model. To account for other influences, we initially included the number of features designed and the experience and age of participants in the model, but these did not correlate with feature novelty. With an R-squared value of 0.196 and a coefficient F-value of 2.509, the variables included in the final model accounted for 19.6% of the variance in feature novelty among participants (with a constant of 2.510).

How Cognitive Style and Gender Explain Feature Novelty

Cognitive Style Alone Does Not Matter
We found that cognitive style was unrelated to feature novelty on its own. Neither a more intuitive nor a more rational dispositional style per se led participants to design a software feature of higher novelty.

FIGURE 1. A selection of designed software features with (a) high, (b) low, and (c) medium novelty scores, respectively.
Female Practitioners Create More Novel Features

Gender, in contrast, was positively associated with feature novelty. We found that the female practitioners in our experiment produced more novel software features than did the male practitioners.

Cognitive Style Matters for Female Practitioners

Cognitive style and gender taken together are also positively related to feature novelty. Female practitioners with a higher intuitive preference designed significantly more novel software features. Additionally, we found that female practitioners produced the most novel features when they had a preference for both intuition and rationality.

The two heatmaps in Figure 2 illustrate the relationships between intuition, rationality, and feature novelty for both male and female practitioners. It is important to keep in mind that only the high intuition and the high intuition with high rationality portions in the female practitioner part of the regression model are statistically significant.

Discussion and Key Takeaways

Our study shows that both cognitive styles (intuition and rationality) as well as gender matter for software feature novelty. The way that they matter leads to several important takeaways from our study.

First, because gender was positively associated with software feature novelty in our study, it is crucial to further investigate the role of female practitioners in software design activities. Perhaps software teams could benefit from involving women specifically, but this needs to be empirically established.

Second, because neither cognitive style was positively related to novelty on its own, it does not make sense to lean on a single cognitive style, independent of other factors, to design novel software features. Previous research and practice in software engineering has generally prescribed the use of rationality either explicitly (e.g., through design-reasoning techniques) or implicitly (e.g., by imposing structured development methods and lifecycle models). Focusing entirely on rationality or intuition is not supported by our study. Instead, other factors need to be considered, particularly the gender of the practitioner.

Indeed, we found that gender has implications for the use of cognitive

![Figure 2](image-url)
styles in software feature design. Female practitioners should not be discouraged from making use of intuition exclusively, or combining rationality with intuition, when designing software features. In practice, intuition can even be promoted through behaviors such as brainstorming and sketching to intuitively come up with potential solutions as well as by giving female practitioners “incubation time” (i.e., a distraction from consciously considering the problem) after being exposed to a problem situation.14

Currently, we cannot draw certain conclusions from the male portion of our regression model; however, it is possible that male practitioners with a dispositional preference for either intuition or rationality design more novel software features than their male peers in contexts other than our study. This also raises the question of whether forcing a rational style among intuitively strong male practitioners is actually beneficial for these practitioners.

To our knowledge, this is the first study that investigates the relationship between the combination of cognitive style and gender, and software-related performance outcomes. We hope that it will encourage further work on this important subject. However, in our study design, we have solely considered a black-box approach to the problem, which does not consider how male and female practitioners might design software features differently. Such white-box studies, particularly qualitative design studies, are imperative for understanding these differences in practice. Perhaps the differences we found can be explained by the pressure sometimes experienced by female practitioners to prove themselves,15 as an example.

We found that female practitioners produced the most novel features when they had a preference for both intuition and rationality.

The black-box nature of our study leads to two further potential limitations. First, although we controlled for many extraneous variables, there are likely other variables, such as self-confidence,10 for which we did not control. Second, although our sample consists of software design practitioners from many different geographic locations and roles in industry, it is possible that our sample is not perfectly representative.

Finally, our study focused on the individual level, and although some aspects of studying individual practitioners can be applied to the team level, researchers should also investigate the novelty of software designed by teams. Teams can differ in terms of cognitive style and gender representation. Interactions between individual practitioners based on these differences could have unique consequences for software novelty, perhaps through issues like groupthink and power dynamics invading or supporting the group context.

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