

## **Understanding the *if* and *when* of the unknown**

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We are all faced with uncertainty about the future.

When will I receive a decision about grant funding?

What if I don't get the job I applied for?

For some of us, uncertainty can create discomfort, but is tolerable. For other individuals, however, uncertainty can be all-consuming, creating constant stress and anxiety.

### ***People vary in their ability to tolerate uncertainty***

Humans seem to prefer certainty<sup>1,2</sup>. This is because uncertainty limits our ability to determine the likelihood, timing, or intensity of an upcoming negative or positive outcome<sup>3</sup>, preventing us from preparing for the future and contributing to anxiety.

*Excessive* anticipation and hypervigilance to uncertain threat appears to be a core feature of anxiety disorders<sup>3</sup>. Consistent with this, anxious individuals exhibit heightened defensive responses to uncertain threat compared to healthy individuals on emotional, cognitive, behavioral, and physiological levels<sup>3-5</sup>. Thus, uncertainty and its anxiety-provoking effects have been a primary focus of clinical research that seeks to understand the development and maintenance of anxiety disorders.

While a wealth of research has examined uncertainty and its anxiogenic impact across diverse disciplines and units of measurement, few studies have characterized the effects of different types of uncertainty and how they affect psychological and biological functioning. That is, it is not well understood if certain types of uncertainty may be *more* or *less* anxiety-provoking.

### ***Certain types of uncertainty may be more or less anxiogenic***

To address this gap, researchers Ken Bennett, Jacqueline Dickmann, and [Dr. Christine Larson](#), published an important article in [Psychophysiology](#) exploring the anxiogenic effects of two different types of uncertainty—temporal and occurrence uncertainty.

“One of the things that was remarkable to me was how little experimental research had really been done examining different types of uncertain outcomes in anxiety”, says Dr. Larson, Professor at the University of Wisconsin-Milwaukee. “[Christian Grillon](#) has done some really seminal work on uncertainty which was really influential. But this was all focused on temporal uncertainty”.

Temporal uncertainty refers to the inability to predict *when* an aversive stimulus will occur. In contrast, occurrence uncertainty, a relatively understudied form of uncertainty, refers to the inability to determine *if* (i.e., the likelihood) an aversive stimulus will occur.

In a sample of 42 healthy undergraduate students, the researchers directly compared the anxiety-provoking effects of temporal and occurrence uncertainty by measuring the size of

participants' startle eyeblink reflex, a physiological index of defensive responding, to impending electrical shocks.

To do this, the researchers modified one of the most widely-used paradigms to manipulate uncertainty, the [No-Shock, Predictable Shock, Unpredictable Shock \(NPU\) task](#). During the task, participants underwent four different anticipation conditions: (1) temporal uncertainty (participants were always shocked, and the shock could occur at any time), (2) occurrence uncertainty (participants may or may not get shocked), (3) certain (participants were always shocked), and (4) safe (participants were never shocked). During each type of anticipation condition, the participants heard a loud sound (acoustic startle probe) and the size of their startle eyeblink response was measured. After experiencing each condition, participants rated how anxious they felt during the condition. Finally, to examine associations between startle responses to each form of uncertainty and anxiety, participants completed questionnaires that assessed characteristic symptoms of anxiety disorders, including worry, negative affect and intolerance of uncertainty.

### *Temporal uncertainty versus occurrence uncertainty*

Results of the study show that startle eyeblink responses were largest when threat was temporally uncertain. That is, participants had more robust startle responses when anticipating a threat that they had some certainty would occur but didn't know *when* it would occur, versus anticipating a threat when it was unknown *if* the threat would occur at all.

"Initially I thought that [occurrence uncertainty] may be more similar to temporal uncertainty in terms of how anxiogenic it was. I don't know if I would say I was surprised [by the results], but they did really make me think that at least in this paradigm, temporal uncertainty was more potent. The idea that when a threat is coming, and it's going to happen, but you just don't know when, can be more anxiogenic than when a threat might or might not happen", says Dr. Larson.

### *A disconnect between the physiological and subjective experience*

Despite temporal uncertainty eliciting greater startle responses than occurrence uncertainty, participants rated these two types of uncertainty as equally anxiety provoking. Furthermore, the researchers did not find an association between startle responses and self-reported measures of anxiety. Dr. Larson explains, "When people retrospectively reflect on how anxious they were in the previous block they say the two uncertainty conditions were the same—they were equally anxiety provoking and more so than the certain threat. There was a disconnect between the physiological of the defensive reflex response and the subjective experience.

"There are a lot of reasons for this. [Defensive reflex and self-report] are such different levels of analysis—one happens on the order of milliseconds and the other does not. It is a puzzle. I think it means that we need to fill in the gaps in these levels of analysis—what are the processes in between these two levels of measurement that can help us explain if they are ultimately related or not?"

### *Looking forward by looking back*

As with the completion of any study, hindsight is always 20/20. Careful and honest considerations of what could have been done differently are important jumping off points for the

evolution of empirical ideas and more rigorous methodological design. Dr. Larson agrees with this sentiment. “I think it would have been nice for us to oversample individuals with anxiety. [Our study sample] comprised fairly low anxious individuals. It would be useful to look at samples with different anxiety disorders or just more anxious individuals in general so that we could get a clearer sense about whether more severe anxiety is impacted by temporal and occurrence uncertainty”.

Additionally, Dr. Larson notes that extending the duration of each anticipation condition may have been useful. “What we didn't do is strategically measure anxiety using fear potentiated startle as participants got closer and closer to when the shock would occur. Some evidence from Dr. Grillon's lab suggests that early in the anticipation period, you don't see much anxiety. Rather, it is only as the threat becomes more imminent that you observe greater levels of anxiety. There may be individual differences in the time-course [of anxious anticipation]—it is possible that anxiety and defensive responses may kick in earlier if you are more prone to anxiety than if you're not. I think that would be really interesting to look at methodologically”.

### **The importance of *if* or *when* across anxiety disorders**

The study's results highlight the importance of parsing the complex construct of uncertainty to understand which of its constituent parts elicits anxiety across different units of analysis. This line of work may have important future implications for understanding common and distinct processes across the anxiety disorder spectrum. For example, uncertainty about *when* a threat will occur may be particularly relevant to post-traumatic stress disorder (PTSD) and panic disorder, whereas uncertainty about *if* and *when* a threat may occur may be important to generalized anxiety disorder (GAD). “In my lab we're continuing to try to think about how different types of uncertainty might be related to anxiety”, says Dr. Larson. “I think PTSD and panic disorder might be the kinds of disorders where temporal uncertainty may be especially important. For example, someone with panic disorder might sit around worrying about when their next panic attack will happen, whereas for GAD, temporal and occurrence uncertainty may both be relevant since those with the disorder experience a level of worry that is so high—the *when* and *if* a threat will occur may worry these individuals more”.

Moving forward, studies will be needed to delineate how various aspects of uncertainty relate to cognitive, affective, behavioural, and physiological changes. Ultimately, this work may help us better understand how uncertainty ‘gets under the skin’ and leads to the development and maintenance of anxiety.

To read this study in *Psychophysiology*, click [here](#).

## References

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- <sup>5</sup>Grillon, C. (2008). Models and mechanisms of anxiety: evidence from startle studies. *Psychopharmacology*, *199*(3), 421-437.