-1 Programmed Ribosomal Frameshifting affects translational efficiency hypothesis (TEH)

**Background**
- 1 Programmed Ribosomal Frameshifting (-1 PRF) is used for protein expression regulation
- Translation Efficiency Hypothesis: codon usage adapted to tRNA abundance to match increased protein expression demand
- Codon usage bias (CUB) associated with protein expression

**Our Vision:**
- Understand how -1 PRF affects codon usage bias (CUB)
- Is there a cost to -1 PRF that affects CUB composition?
- Do CUB indices appropriately reflect the translational efficiency of mRNA?
- How can we correct for the translational mismatch?
- Does the TEH hold after correction?

**Evidence for a cost to -1 PRF maintenance**

**Independent effects arising from a -1 PRF cost;**
- If protein expression demand increases, we expect that evolution will
  - remove slippery site
  - shorten frame-shifted frame length

**Hypothesis testing:**

**Retesting the translational efficiency hypothesis (TEH) under new codon usage bias index**

**A -1 PRF corrected codon usage bias index**
- \( L(x) = \left(1 + 1 + \lambda + \frac{p - 1}{p - 1}ight)^{-1} L(x) \) or \( L(x) = (1 - p)L(x) + pL'(x) \)
- \( L(x) \) is any codon usage bias index. It is the cost of translation interruption. Else, as in left fig.

**Translational efficiency hypothesis (TEH) is supported by data**
- We tested whether TEH holds when using correction

**Conclusion**
- The translational efficiency hypothesis is strengthened
- The cost of -1 PRF is likely to affect codon usage bias in different ways
- -1 PRF can be used as "natural experiment" to study codon usage bias.
  - Perhaps can be used to differentiate between selection for accuracy and efficiency in certain contexts

**References**

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