Data driven modeling of G protein signaling in plant cells

Kang-Ling Liao[1] **Charles E. Melvin**[2] **Rosangela Sozzani**[2] **Roger D. Jones**[3] **Timothy C. Elston**[4*] **Alan M. Jones**[5*]

[1] *University of Manitoba, Florida Atlantic University, 420 Machray Hall, 186 Dysart Rd. Winnipeg, MB, Canada* Kang-Ling.Liao@umanitoba.ca
2 *Department of Plant and Microbial Biology, North Carolina State University, Raleigh, NC, United States of America,*
3 *Center for Complex Systems and Enterprises, Stevens Institute of Technology, Hoboken, NJ, United States of America*
4 *Department of Pharmacology, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States of America* timothy-elston@med.unc.edu
5 *Departments of Biology, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States of America* Alan-Jones@unc.edu

In animal cells, activation of heterotrimeric G protein signaling generally occurs when the system's cognate signal exceeds a threshold, whereas in plant cells, both the amount and the exposure time of at least one signal, D-glucose, are used toward activation. This unusual signaling property called Dose-Duration Reciprocity, first elucidated in the genetic model Arabidopsis thaliana, is achieved by a complex that is comprised of a 7-transmembrane REGULATOR OF G SIGNALING (RGS) protein (AtRGS1). D-glucose operates through the AtRGS1 protein complex to activate G protein signaling by WNK kinase transphosphorylation of AtRGS1. Because WNK kinases compete for the same substrate, AtRGS1, we hypothesize that activation is sensitive to the AtRGS1 amount and that modulation of the AtRGS1 pool affects the response to the stimulant. Mathematical simulation revealed that the ratio of AtRGS1 to the kinase affects system sensitivity to D-glucose, and therefore illustrates how modulation of the cellular AtRGS1 level is a means to change signal-induced activation. AtRGS1 levels change under tested conditions that mimic physiological conditions therefore, we propose a previously-unknown mechanism by which plants react to changes in their environment.

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References

[1] K.-L. Liao, C.E. Melvin, R. Sozzani, R.D. Jones, T.C. Elston, and A.M. Jones, 2017, Dose-duration reciprocity for G protein activation: modulation of kinase to substrate ratio alters cell signaling, *PLoS ONE*, No. 12(12), e0190000.