Entrainment Concepts Revisited

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Supplementary Online Material

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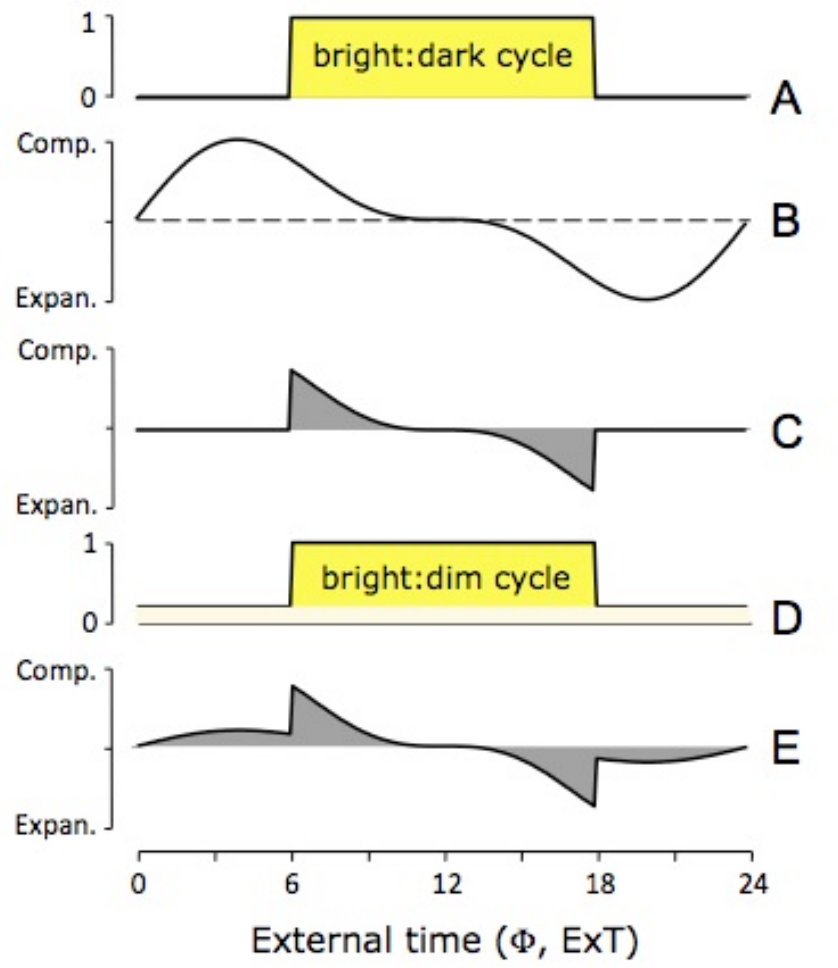

Figure S1. Predicting the phase of entrainment by the CIRC is not only possible for L:D cycles. Since the responses of the normalized CIRC are multiplied by the intensity of the light (using a conversion factor, c_{ZG}, that has to be calibrated for each system), it is also possible to predict entrainment in bright:dim light cycles. The example shown here is again the simplest form of entrainment, namely $T = \tau$ and a symmetrical CIRC with a moderate dead-zone ($s = 0.5$). Panel C shows the integrals (gray areas) that result from the CIRC shown in B and the L:D cycle shown in A. They fulfill the criterion that the compression and the expansion portions cancel each other out. The same is true for the integrals shown in panel E, which result from combining the same CIRC with the bright:dim light profile shown in panel D. All ordinate scales are relative units.

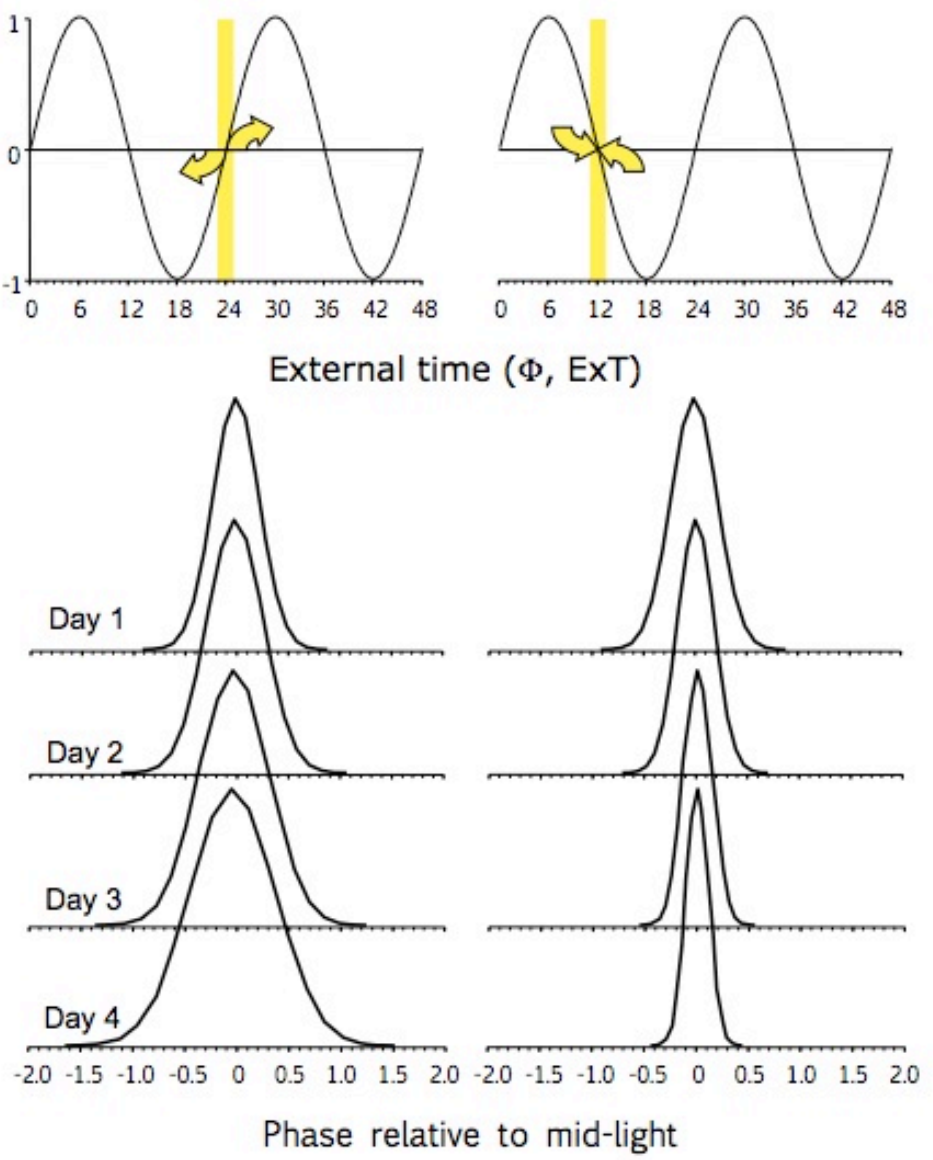

Figure S2. If τ = T and a symmetrical CIRC) has no dead-zone, then two alternative solutions fulfill the criterion of producing no net compression or expansion (see top panel): (a) when the light is centered around InT0/24 (top left panel) and (b) when it is centered around InT12 (top right panel). The left example does however not lead to stable entrainment because the responses will drive the internal phase away from the light pulse if τ is not exactly equal to T (yellow arrows). If light hits too early (*i.e.*, exposing more of the expansion portion) the next light signal will hit an even earlier phase and so on. If light hits too late, it will hit even later in the next cycle. In contrast, light will focus the clock to the middle of the light period around InT12 (yellow arrows). If light hits too early it will fall on a later internal phase the next cycle and if it hits too late it will come at an earlier internal phase in the next cycle. Since most circadian systems are made up of populations of oscillators, this principle will lead to a broadening of the phase distribution when light falls at around InT0/24 (lower left panels) and will narrow the distribution when falling at around InT12 (lower right panels).