Table 1: Correspondence of designs, study types and dynamical modeling steps.

Study Aim	**Smoking Behavior Study Type**	**Time Series Steps**	**Control Model Steps**	**Demonstration Data**
Develop dynamical models of self-regulation	Descriptive Longitudinal & Momentary Behavior	1. Characterize the *Stability of a Process* and its time varying covariates	1. Identify basic *Control Process*	TERN, Richmond, Mooney, Jamner data
Assess change in self-regulation	Interrupted Time Series; Cessation & Intervention	2. Assess interruption effects on the *Stability of a Process*	2. Assess intervention effects on the *Control Output*	Shiffman data
Characterize change in self-regulation over intervals of calendar time	Longitudinal Measurement Burst & Natural History of Momentary Behavior & Developmental Course	3. Assess the long-term trend of the *Stability of a Process*	3. Characterize the over-time structure of the control process	Rende and Jamner data

fitted autoregressive coefficients across individual series will be conducted. Second, transfer function and other approaches to evaluating influences among multiple concomitant time-varying series will be explored.

A.1.ii Identify the Basic *Control Process.* In the case of time series, the level and stability of one or more processes are of interest. In this case, the multivariate drivers or “inputs” to the process are simultaneously specified in feedback loops. This loop contains sensors akin to temperature gauges, decision rules and actions, all of which are specified to operate within a given range. The first aim in translating this model to smoking research, therefore, is to extract starting parameter values from representative individual smoker’s cases or pooled data in studies of momentary smoking patterns. Initial efforts will allow simulation of the smoking control process in a manner akin to that used by engineers. Subsequent steps tied to this aim will be to convert the model to be stochastic on two dimensions, the time dimension initially (using time domain methods of estimation, such as time series), followed by the subject dimension (as in the case of multilevel models).

A.2 Assess change in self-regulation upon smoking cessation.

A.2.i Assess intervention effects on the *Stability of a Process*. One of the greatest benefits to assessing treatment effects in cases where a process has been monitored before and after an intervention is the use of models to describe a ”process interruption”. In the time series domain, these models are referred to as interrupted time series models [59, 60, 61]. However, most consideration of this approach has been devoted to a shift in the level of the process, not to a change in the stability of the process. Moreover, with longer series, the process may no longer be identified as being the same before and after an interruption. Hence, in this aim, I will develop materials and demonstrations to aid users in evaluating interrupted time series for changes in the stability of a process.

A.2.ii Assess intervention effects on the *Control Output*. Unlike in the time series aims, which are largely independent, the second and third aims in control modeling both rely on some success of the first aim. Depending on the extent to which the control system can be modeled for these data, this aim is to carefully evaluate various options for assessing the impact of an intervention in the control modeling context. Three possibilities are already apparent. First, the change may be modeled simply as a change in one or two variables, such as a reported drop in the urge to smoke by participants following medication. Second, the entire system may be operationalized differently, whereas the pre-intervention output of interest may be actual smoking, the post-intervention output of interest may be urge. Third, new variables may enter into the pre-intervention system, such as medication, health behavior or other contextual influences. This is an ambitious aim to be pursued during the proposed award period, however, a specific outcome in this case is to generate a review paper of modeling options for assessing intervention effects using control models.

A.3 Characterize change in self-regulation over intervals of calendar time.