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Title: Tutorial on A Theory-Driven Methodology For Identification of Vital Properties of Elementary Cognitive Processes: Systems Factorial Technology

Abstract: The cognitive revolution re-opened questions about human perception, cognitive functions and action that had laid more or less dormant since the nineteenth century. However, there is a reason behaviorism won such a wide and persistent popularity for several decades: mental operations are extremely challenging to assess due to their black box nature. In fact, the first author has demonstrated that even incredibly simple opposed hypotheses, such as the parallel vs. serial processing issue, can be impossible to test in commonly employed experimental designs. The major culprit is model mimicry at the level of mathematical equivalence. A functional equation which explicitly states the parallel-serial mimicry issue, in the case where n=2, is provided by

$$\text{SERIAL: } p\, f_a(t) \equiv g_a(t)\, \bar{G}_b(t)\text{: PARALLEL}$$

$$\text{SERIAL: } (1-p) f_b(t) \equiv g_b(t)\, \bar{G}_a(t)\text{: PARALLEL}$$

Where p=probability of processing item 'a' first in a serial system and $f_i(t)$, i=a,b is the serial probability density on the (serial) processing time for item i. Similarly, 1-p = probability of processing 'b' first in a serial system. On the parallel side, $g_i(t)$ is the parallel probability density on processing time for item 'i' and $\bar{G}_i(t)$ is the survivor function (i.e., 1-CDF) on the parallel processing time for item 'i'. This functional equations has solutions which are given in Townsend (1976, JMP). Over the years, the first author along with students and colleagues, developed a number of strong experimental paradigms capable of attacking such issues, and skirting the mimicry dilemma. The most popular is *systems factorial technology (SFT).* SFT is comprised of a set of distribution-free predictions and tests of properties such as mental architecture (e.g., the parallel vs. serial issue), decisional stopping rules, and workload capacity. Although these properties and mechanisms are tightly interwoven in functioning systems, they are independent concepts. This talk will focus on architecture and stopping rules leaving the topic of workload capacity to a subsequent presentation. The foundational assumption (*empirically testable*) is that experimental factors can be found which elicit stochastic dominance (ordering of the process time CDFs) of the subsystem processing times. This is known as the Assumption of Selective Influence. If selective influence holds then a key statistic for systems identification is

$$S_{LL}(t) - S_{HL}(t) - [S_{LH}(t) - S_{HH}(t)] \text{ for all } t \geq 0,$$

Where $S_{ij}(t)$ is the data (or prediction) survivor function for factorial condition i, j = L (low factor setting), H(high factor setting). The predictions for parallel and serial systems accompanied by distinct stopping rules will be exhibited and discussed.

Details of the methodology and many recent applications to a variety of perceptual, cognitive, action and social phenomena can be found in Systems Factorial Technology: A Theory Driven Methodology for the Identification of Perceptual and Cognitive Mechanisms (2017). by D.R. Little, N.Altieri, M. Fific', and C-T Yang (Eds.), New York: Academic Press.