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Loehlin's Original Models and Model Contributions

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Abstract

This is a short story about John C. Loehlin who is now at the University of Texas at Austin, dealing with his original simulation models and developments, which led to his current latent variable models. This talk was initially presented at a special meeting for John before the BGA in Rhode Island, and I was very pleased to contribute. It probably goes without saying, but John helped create this important society, has been a key contributor to this journal for several decades, and he deserves a lot for this leadership.

Initial Models

When he was a young professor at the University of Nebraska in 1961, Loehlin's very first publication was an interesting piece on "word meaning and self perceptions" (Loehlin, 1960). While the concept and the data analysis presented in this paper has little to do with the isolation of characteristics that might be relevant to behavior genetics, it is characteristically thoughtful and instructive. Nevertheless, I will not give further details on this analysis now.

His next early contributions were on "computer models of personality" (Loehlin, 1962, 1963, 1968) and we again can find very little of behavioral genetics. The idea originated in a paper presented by Loehlin at a conference on computer simulation and personality theory held by the Educational Testing Service at Princeton University. The basic purposes and ideas in the computer simulation of psychological processes and behavior had been well defined by this time (see Hovland, 1960). For example, Although it was already well-known at the time that the computer could be used as a quick and efficient mathematical calculator and this opened up new avenues of statistical research, other potential uses were still not well-understood.

Tompkins & Messick (1963) reported that the computer could be used to empirically test the validity of ideas and theories of personality to their fullest extent. Whereas a scientist might not have the time (or patience) to carry out all of the possible interactions and probable occurrences of (as an example) Estes' (1960) "Stimulus Sampling Theory" (i.e., learning reinforcement over trials; see Bower, 1994), with proper programming the computer could do this in seconds and yield information regarding some or all of the various hypotheses over time, etc. These were early developments in what is now known as "computational

modeling” (for details, see Sun, 2002), and it remains relevant today for most theories and human behaviors. By developing computer programs of cognitive processes, we can debug our ideas about the scientific validity of our psychological theories.

Initially Loehlin basically created a small world of simulated automatons (termed Aldous after the author Aldous Huxley) and had them interact with one another to better understand what he had created. He defined each to have a “personality” or probabilistic way of reacting to threat – The “experiments” he ran with these different simulated creatures. Little did we know that he was doing all of this as an Assembly language code (of binary digits). In McArdle (1973), I first learned about this work and I tried to mimic this in my own way, using what were thought of as the best computer programs at the time (FORTRAN). I created a simulated student in a simulated college, doing simulated tasks like picking a major and getting grades. On the whole, I still think this was all pretty good for a college student.

A major product along these lines was made by John Loehlin. In an effort to define and evaluate the major factors in “personality theory” Loehlin (1962, 1968) produced a computer program that was used to act as the intermediary between perception (input) and behavior (output). The thought was that if the major factors in the computer’s behavior could be shown to be empirically different than human behavior, we could assume either that the input (as the model defines it) is incomplete or not a good representation of human perception, or that the model itself has not taken into account some (or any) of the important factors. However, if the output quite closely resembles known human behavior, we could not deny the possibility that the human psychological process is very similar to the operation that have been defined by the computer model. In practice, due to the limited controls available, it may be able to produce unexpected human behavior. That is, we cannot choose among the possibilities until some other model is developed which more closely resembles the human output!

Loehlin wrote his computer program in the early 1960s, but it is still referenced as the classic attempt at a simulation model in the field of personality research (Lewis, 1971). In fact, it seems to me that Loehlin’s was the first “Agent-based” program of its kind in social psychology. Loehlin named it “Aldous” because he felt that the model was a “Brave New World” indeed. Following is a basic description of the program itself, some experimentation done on the behavior of Aldous, and some comments by professionals from the same ETS conference.

For those with some computer knowledge, Aldous was originally written on a Burroughs 205 entirely in “Assembly Language” (with 750 instructions— such as “Get the Number in Cell XXXXX, Add it to the Number in Cell YYYYY, and Store the Result in Cell XXXXX. This was quite a programming feat in itself!). Generally, Aldous was presented a situation with certain characteristics and he responded based on some knowledge that had been previously acquired. Depending on the nature of the situation, Aldous may or may not receive further consequences. Although a complete technical description of the program will not be offered here, the reader can refer to Loehlin himself for more details (Loehlin, 1963; 1968).

The *Situation* (external to Aldous) was defined with seven numbers. The first three were perceptual characteristics (0–9 for each of three dimensions, thus there were 1000 possible perceptual situations). The next four numbers correspond to affective characteristics of the situation developed from Murray's (1938) theory of situational "presses." The four presses were defined as the relative probability of each situation to cause satisfaction, frustration, pain, and its power to do so. Thus there can be many combinations of stimulus perceptual characteristics. One can easily see how Aldous was never without something to do.

Memory (internal)

Aldous had two separate storage locations – termed "immediate" and "permanent." In both of these Aldous had the capacity to save information about how many times the present perceptual situation had been faced previously, how he responded to it each time before, and the class of perception and press to which this situation belongs. After Aldous responded, he had a capacity to adjust each of these memories to a degree that depended upon the reaction he produced, the consequence that the reaction produced, and the relative intensity of the response and the reaction. It is interesting here to note that Loehlin gave greater weight to recent memories, and that Aldous had the capacity to give a verbal (via a printout account) of his various memories at specific times. Loehlin called this "introspection."

Recognition (internal)

once a stimulus situation had been introduced to Aldous he compared the situation with his memory. This included traces of previous encounters with the same and similar situations in the same perceptual classes. In addition Aldous examined each press at essentially the same time for their individual attributes. Loehlin attempted to simulate human perceptual error by introducing a 6% error rate in this subsystem – That is, to better mimic the human personality 6 out of every 100 stimulus characteristics were not recognized accurately by Aldous.

Emotional Reaction (internal)

Once the situation was recognized by Aldous, an emotional reaction was developed based on the situational characteristics and the familiarity with the situation itself. For instance, if Aldous had never been exposed to a situation before, he would react based on any prior experience with similar classes of experience; Alternatively, if he has been exposed to that situation a few times before, he reacted based on this "experience." In general, weight was given to the memories of that situation and to just the class of experiences but only if Aldous is familiar with the situation itself. In all, about 80% of responses were based on memory, and 20% were based on Aldous's current mood (i.e., traces left from previous emotional characteristics). In terms of the reaction, Aldous had three possible emotional characteristics with which to react: (1) positively or with love; (2) with anger, or (3) with fear. Aldous calculated his own response predilection towards each of these. If one response was dominant, it interacted with its competitors to weaken them. If no response tendencies had been developed to a greater degree than another, Aldous developed emotional "conflicts."

Action preparation (internal)

Aldous next selected an action based on the final emotion selected. He had three possible actions that corresponded to these emotional reactions: (1) approach; (2) attack; or (3) withdrawal. In addition, each of these could have two action strengths: (1) mild or (2) vigorous; or two non-action strengths (1) no action necessary or (2) emotional “paralysis” (primarily caused by conflicts of relatively strong emotions). Thus, with all of many possibilities of interactions of this behavior will be “physical” in only six ways (a common 3 by 2 design). Only the verbal reports will show anything other than this.

Consequences (external)

Considering the presses of the situation, and Aldous’ behavioral actions, the external situation could feedback and affect Aldous in several ways. In fact, if Aldous approached there was always some consequence. If Aldous did nothing the situation must have some ability or power to affect; if Aldous avoided or attacked mildly the situation might have relatively high power; and if Aldous avoided or attacked vigorously the situation a very high power to cause a consequence. If there was no consequence there is no change in memory, but if there was a consequence there is a change in memory – Loehlin called this change “learning.” The consequence effects the situation and the response tendencies depend on the experience. That is, the more familiar Aldous was with the situation the less any consequence could happen that changed his “ideas” about it. This affected the entire class in the same way, but with less of an effect.

Experiments with Aldous

To many other scientists, this was simply grand theorizing about Personality. But in an effort to explore the complexity that was incorporated into this computer model, Loehlin exposed Aldous to variations of his standard model using different perceptual settings (or “worlds”) to see just how he acted. Loehlin (1963) described two experiments with the standard Aldous, and then conducts the same experiment with five other Aldouses, each with some trait change. Due to the detailed nature of this paper and his book (Loehlin, 1968), this is only a brief description of experiment results (see his Figure 1) and these results are presented here without the detailed analyses they deserve.

Effects of different stimulus situations

Loehlin defined several “worlds” for Aldous. The first was a hostile world where the presses of all the stimuli were injurious or frustrating. The second was a benign world where all the presses were satisfying. Using a then-standard personality inventory, Loehlin concluded that within 12 trials, Aldous started to show the effect of his environment. After 500 trials Aldous approached on 85% of the time in the benign world and not at all in a hostile one. Although, Aldous found adjustment quicker in the favorable environment (the “Good” versus “Bad” Aldous) he reached similar levels in both worlds!

Shift of environment

After allowing for 500 “growth” trials in each environment Loehlin switched each Aldous to the opposite world. Loehlin found that the fearful Aldous took longer to discover his environment than the approaching Aldous.

Trait changes

By adjusting some of the many constants in the program, Loehlin was able to develop other “types” of Aldouses. The most well-known may be “Bad-Aldous”, but Loehlin considered:

Abstract Aldous—Putting more weight on general classes rather than concrete situations allowed this version to react to things in broader, more categorical terms. Loehlin found that this Aldous was slightly more consistent and extreme. He approached more in benign situations, and less in hostile situations. He also shifted more easily; But the overall adjustment was similar.

Hesitant and Decisive Aldous—With different critical values for the transfer of emotion to action Loehlin developed one Aldous that wouldn’t act until strongly emotional (hesitant) and one that acted with vigor in the presence of the slightest emotion (decisive). Not surprisingly, Loehlin found that the hesitant Aldous acted less, and because of this passivity, was able to shift easier from benign to hostile.

Radical and Conservative Aldous—Allowing for changes in the past environment or emotional reactivity and corresponding action, one Aldous worked mostly on immediate memory (radical) and one on permanent memory (conservative). Loehlin found not as much of a difference between these versions as he found between other Aldouses except that the radical version adjusted quickly to most environments and displayed less overall paralysis.

Overall, Loehlin concluded only that trait changes didn’t affect personal adjustment too much; the speed of personal adjustment depended on the interaction of the environment personality type; and finally that different styles of behavior can lead to the same final level adjustment. Although it may not be possible to say whether or not this model actually worked the way it was intended, it certainly told us a lot about the complexity of its creator.

Initial Conclusion

Loehlin spoke of this whole enterprise as an attempt to develop a “model of personality.” He energetically spoke of improving upon Aldous’s (a) limited ability to plan based on more than one situation, (b) his rather limited perceptual system and memory, and (c) the use of too many constant values. Loehlin considered Aldous as a first step only because of the development of a super program which might tell us how to develop a better model. On the future of simulation modeling he says “when you ever want to represent complex dynamic system, there is an advantage in using one.” (and see Lewis, 1971)

In the same book (see Loehlin, 1963), there were two discussions presented on Aldous itself. W.H. Holzman (“*The robot personality – static or dynamic*,” pp. 213–220) discusses some of the problems of Loehlin’s computer program, but Holzman’s basic conclusion was that

the overall idea had merit, but that personality may be too complex to attempt at that time and maybe smaller models of say, the perceptual system, or a verbal learning model, might be more amenable to approach. He also he say he feels that the model should have more of a dynamic ability to change intensity and patterning of Aldous' own traits if it is to survive as a workable model. G. A. Kelly ("Aldous: the personable computer," pps. 221–229) wrote about the possible contributions of simulation modeling to experimental psychology. "We can stipulate the logic of the theoretical system and with a series of inputs, explicate the theory and its implications in ways the original theoretician would take a lifetime to figure out and check on his own."

Since the time of the 1962 conference an incredible amount of research has been done in this field, with perhaps the best early summary by Michael Apter (1971). A final tribute should be given to Loehlin's pioneering work in this field. It was indeed a classic in the area and he seemed to pass the Turing (1950) test for human-computer interaction; Even now the Aldous computer program is very hard not to refer to as "he or she" (and see the cover of his book).

Model Developments

But today, we recognize this kind of computer simulation as a very big deal. The imitation of a complex real-world process is used in most every "agent-based" computational model (sometimes termed a "sim") in social psychology and computer science (see Sun, 2002). Simulation is also used in a variety of training scenarios, such as Flight Simulator and even in SimCity 3000. Indeed, these rank among the most important of PC-uses. But complex systems predictions now require generating dynamic data from different scenarios and averaging these to make a prediction is being used in all sciences (think of foul weather). But this was not the explicit direction taken by Loehlin.

It is clear that Loehlin (1968) could have lived entirely off this groundbreaking work on Aldous and personality theory, but he did not choose this path. Instead, he worked back to his roots in empiricism and data analysis, albeit of a complex variety, but perhaps this could be seen as the opposite of his highly theoretical work with Aldous. I first came to understand Loehlin's empirical approach in his original (see Loehlin, 1965) classic critique of Cattell's (1960) "Multiple Abstract Variance Analysis." As I came to see it, this analysis proved to be a watershed. In the MAVA model R.B. Cattell, largely based on Cattell's deep understanding of algebra, created a broad analytic system for the analysis of any complex phenotype into genetic and non-genetic elements, both between and within groups; it predated most commonly used behavioral generic models (see Jinks & Fulker, 1970; McArdle & Prescott, 2005). But Loehlin (1965) suggested that the great R.B. Cattell was actually incorrect about one path in his big theoretical model. But since it was just one path, this question was summarily dismissed by Cattell until much later (maybe 1988). Of course, Loehlin (1965) had simply asked, "Is the path really the number 2 or is it the $\sqrt{2}$?", and he was certainly correct (e.g., It was $\sqrt{2}$). But maybe this kind of complex MAVA system created by Cattell was easy for Loehlin to deal with after he had created a complex personality theory like Aldous. It is hard to tell. But I do think this is when he came to appreciate what could be learned from a different kind of modeling – the *structural equation modeling* (SEM) of real data.

Loehlin himself did a lot to better understand real multivariate and longitudinal genetics data and models (in Loehlin & Vandenberg, 1966, 1968 he produced a common factor model for both generic and non-genetic latent variables, predating Martin & Eaves, 1977, and McArdle & Goldsmith, 1990). During the more recent years, Loehlin also developed an eagerness to understand personality from empirical data (a) the multivariate structure of personality (see Loehlin (1965, 1968; see Loehlin, Horn & Willerman) (b) the genetic and non-genetic sources of personality (see Loehlin, 1982, 1987; see also DeFries, Vandenberg, & McClearn, 1976), (c) the methods we all use (see Loehlin, 1993, 1987–2007), and (d) the data we select to make our cases (see Loehlin, 1979, 1987; see McArdle & Prescott, 1996). In all of these treatments, he proved to all of us that he was simply ahead of his time.

Throughout this time it also seems Loehlin had become a highly-respected advocate of “Latent Variable Models” (see Loehlin, 1987–2007). He used this latent variable approach to test his complex ideas in real data (see Loehlin, 1982, 2000; Plomin, DeFries, & Loehlin, 1977; Loehlin & Horn, 2002; Loehlin, Neiderhauser & Reiss, 2007). His own textbook is on “general” principles of SEM with latent variables, not completely about behavior genetic principles. This may surprise some of the readership. Special considerations are given to generating model expectations, hazards of fitting models to real data, and the principles of evaluating the goodness-of-fit. This is actually a *tour-de-force* in SEM that should be required reading for all prospective modelers. He also once said (Loehlin & Horn, 1989) that, “Path model representations of developmental phenomena have at least one advantage over most verbal descriptions: they are explicit.”

I can say this with some authority because he even criticized my own work on this SEM topic by saying, “This is not a very transparent equation” (McArdle & Goldsmith, 1990; McArdle & Prescott, 2005) although he later came to respect my inclusion of a “triangle” (see McArdle, 1986). But I will never forget when he once uttered the greatest single line of what I would call a rational person, “There are only two kinds of analyses: Literary Analysis OR Path Analysis – which is this?” (comment on an SRCD symposium, by discussant John C. Loehlin, 1985).

Final (and Personal) Notes

There are many phenomenal aspects of the work of John C. Loehlin that could be discussed (see the rest of this *Festschrift*) and I have only focused on one of these. I intentionally picked Aldous because most people who read this journal may not know about (or have forgotten) it.

It is no exaggeration to say that I have admired the work of John C. Loehlin and been influenced by it for my entire career. He is a giant in the field of personality theorizing, behavior genetic analysis, and SEM analysis. It is also not saying much to say that he helped get me started in this field, because he actually helped a lot of people (e.g., Hill Goldsmith, Eric Turkheimer, Michael Bailey, and so on) but we all owe him a great deal.

I can recall that after working with John L. Horn on a grant proposal on gathering and modeling data on WAIS (in 1977) we were visited by an NIH site reviewer named J.C. Loehlin at the Department of Psychology, at the University of Denver. Now I was actually

far too young to know what was going to happen, and I did not anticipate what John was going to ask, all about and the use and misuse of Linear Structural Equation Models (e.g., using LISREL). In this avenue, Loehlin did not disappoint us. We talked for hours about our plans, and his advice was very important to our further work. Of course, we are still today trying to accomplish what he said then. But it was all very complex...

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